Journal of Chemical Education

Published by
Division of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing, at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924

Vol. III **June, 1926** **No. 6**

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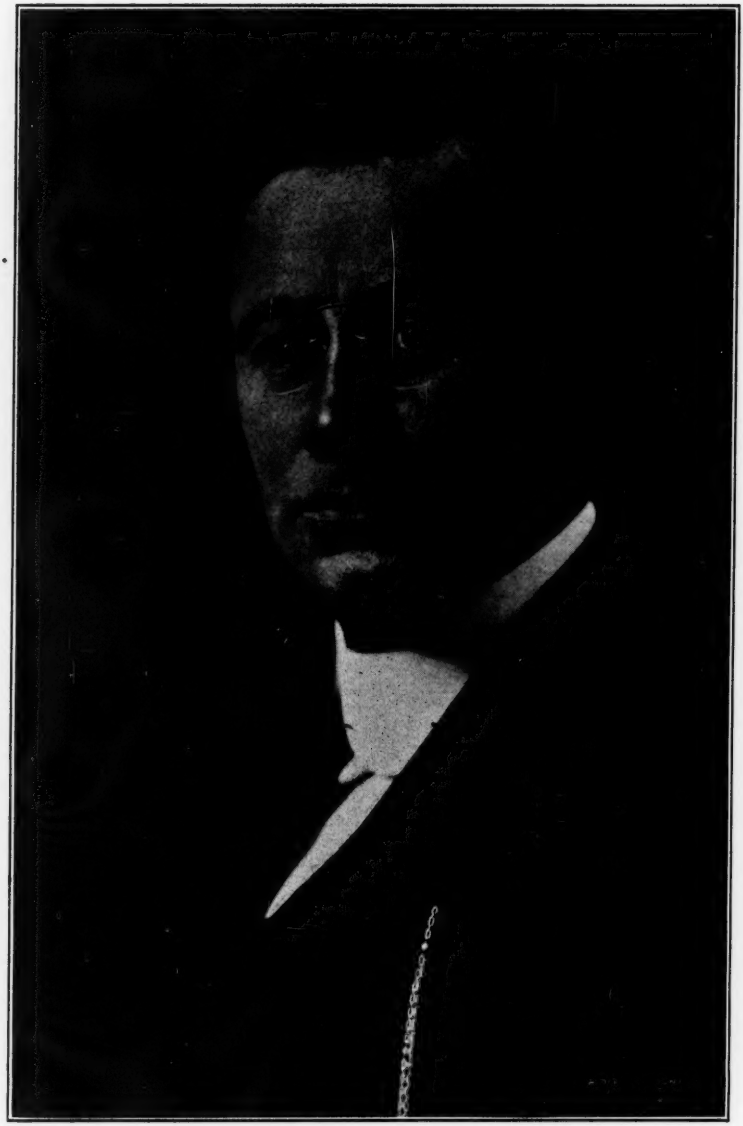


FRANCIS P. GARVAN

EDITOR'S OUTLOOK

A Practical Idealist

THE achievements of modern chemistry, both theoretical and applied, are a never-failing source of interest and inspiration to every chemist and student of chemistry. The contemplation of that which has already been accomplished naturally leads us into speculations concerning probable and possible future developments. Some of the more imaginative and articulate have published their musings along this line.

Among those who have sought to translate their visions of future possibilities into constructive action few are worthy of a more prominent place than Francis P. Garvan, whose portrait appears on the opposite page. Mr. Garvan's interest in chemistry and his devotion to the promotion of research and education in chemistry are all the more noteworthy in that he is by training and profession a lawyer rather than a chemist.

At the outbreak of the war he was placed in charge of the New York office of the alien property custodian and was immediately impressed with the extent to which control of chemical industries in this country had passed into German hands. Undoubtedly his findings led to the creation of The Chemical Foundation which undertook to save the chemical industries from threatened disaster. Mr. Garvan was at that time selected and still remains the president of the Foundation.

Unfortunately the greater portion of the income which the Foundation had hoped to devote to education and research, has been absorbed in defense against prolonged post-war litigation. This, however, has not deterred Mr. Garvan from carrying forward the program arranged, nor has he hesitated to give generously of his own fortune when means were required.

The Foundation has wisely chosen to work mainly through existing agencies, furnishing the encouragement, coöperation, and financial support necessary to overcome the obstacles in their paths. Its educational work has been directed largely into popular channels. "Chemistry in Industry," "Chemistry in Agriculture," and the forthcoming "Chemistry in Medicine" are being made available to the public at cost by the Chemical Foundation. The awards for the American Chemical Society Prize Essay Contests have been donated by Mr. Garvan and his wife in memory of their daughter, Patricia.

These and similar projects have been based upon a realization that a self-sustaining chemical industry backed by well-endowed and well-equipped research and educational institutions must depend upon the support of an enlightened and appreciative public. Thus the work of the Foundation has been catalytic as well as directly creative, for there can be no doubt that the Foundation has inspired gifts and endowments far in excess of those which it has itself been able to make.

We venture to predict that unless Mr. Garvan succeeds in completely submerging his own identity in that of the organizations through which he works, as seems to be his wish, he will some day be rated high among the great constructive Americans. At any rate posterity will realize that a great work has been done.

Sesquicentennial Meeting

THE fall meeting of the American Chemical Society at Philadelphia during the week of September sixth bids fair to be one of the greatest in the history of the organization. The location, in the heart of a great industrial and educational area, will make it convenient for large numbers to attend and the added inducement afforded by the sesquicentennial exposition will doubtless attract many who would not otherwise feel justified in making the necessary outlay.

The chemists may count themselves fortunate in that their meeting comes at a time when the most pessimistic estimates agree that the exposition should be in full swing, whereas present visitors to Philadelphia are disappointed to find the exhibits and many of the buildings far from complete. The sessions of the Society are being planned to leave practically all afternoons free, an arrangement which will meet with the approval of all.

The exposition is, of course, in its entirety a demonstration of the contributions of chemistry to material civilization. It will, however, include in addition an enormous number of avowedly scientific and industrial exhibits. Nor will any teacher willingly miss visiting the section devoted to education—the most ambitious display of its kind which has taken place within the memory of most of us.

The Division of Chemical Education anticipates a well-filled program of more than usual merit. Papers are to be grouped around four general topics: chemical engineering education, the history of chemical education, chemical education in foreign lands, and problems in secondary chemical education. Topics and abstracts of papers to be offered for this meeting should be in the hands of Secretary B. S. Hopkins, University of Illinois, not later than July 25th.

CLOSELY following the announcement of the establishment of an English scientific press service comes the news that a similar agency has been organized in France under the title of *Office d'Information*

Science Service for France

Scientifique et Technique. Both organizations are similar in scope and aim to our own *Science Service*.

We are glad to note that scientists everywhere are becoming increasingly aware of the desirability of correctly informing the public on scientific matters. Possibly this growing realization is not entirely free from considerations of self-interest. Certainly no one attempts to deny that a public which is capable of an interest in and an intelligent appreciation of scientific accomplishment will more readily contribute the means necessary to advance scientific investigation.

There is, however, a much graver need for popular education than is involved in any question of means. We have no desire to join the ranks of the alarmists and attempt to terrorize the timid with another menace to civilization, yet the late Scopes trial with the ensuing flood of state anti-evolution bills and general anti-science propaganda would seem to indicate clearly enough the advisability of taking thought. What most educated people seem to experience difficulty in realizing is that some of these propagandists, and certainly most of their followers, are abysmally ignorant enough to be entirely sincere in their absurdities. And we submit that sincerity, howsoever mistaken, is a dangerous characteristic in an opponent, particularly in a social order which appears thoroughly convinced of the possibility and desirability of salvation by legislation.

Yet these are, after all, rather gloomy musings. There is perhaps more inspiration to be derived from a contemplation of the positive benefits which would attend a more wide-spread enlightenment. Various economists have from time to time pointed out in terms of millions of dollars the increased material productivity which could be expected to follow upon the extermination of this or that physical ailment. Surely the potential subjective and objective effects of even a slight mitigation of the prevailing ignorance of science are not by any means to be sneezed at.

To quote one of Dr. Glenn Frank's recent newspaper editorials:

> All the sciences have lying, relatively unused, in their laboratories socially usable ideas that would, if really used, lift the whole tone and temper of American life.
>
> Unfortunately many of these ideas are today buried under the jargon of technical scholarship and effectively insulated from contact with our common life.
>
> . . . . . .
>
> The scientist is the hope of civilization, but his contribution does not become a social asset until it gets beyond the stage of inarticulate accuracy.
>
> . . . . . .
>
> Because of all this, the most useful man in America today is the occasional scholar-genius who combines the burrowing qualities of the mole with the singing qualities of the lark, the man who is master alike of the science of research and of the art of expression.

"Science and Poetry"

CARDINAL NEWMAN once remarked that, "men, whose minds are possessed with some one object, take exaggerated views of its importance, are feverish in the pursuit of it, make it the measure of things which are utterly foreign to it, and are startled and despond if it happens to fail them." Perhaps in our insistence upon the importance of scientific education we are sometimes in danger of falling into this error and neglecting the fact that, essential as an understanding of scientific facts and attitudes may be to intelligent conduct in the modern world, it cannot ever constitute the entirety of any adequate philosophy of life.

I. A. Richards[1] makes the point in these words:

> Ever since man first grew self-conscious and reflective he has supposed that his feelings, his attitudes, and his conduct spring from his knowledge; that as far as he could it would be wise for him to organize himself in this way, with knowledge as the foundation on which should rest feelings, attitudes, and behavior. In point of fact, he never has been so organized, knowledge having been until recently too scarce; but he has constantly been persuaded that he was built on this plan, and has endeavored to carry the structure further on these lines. He has sought for knowledge, supposing that it would itself directly excite a right orientation to existence, supposing that, if he only knew what the world was like, this knowledge in itself would show him how to feel towards it, what attitudes to adopt, and with what aims to live. He has constantly called what he found in this quest, "knowledge," unaware that it was hardly ever pure, unaware that his feelings, desires, attitudes, and behavior were already orientated by his physiological and social needs, and were themselves, for the most part, the sources of whatever it was that he supposed himself to be knowing.
>
> Suddenly, not long ago, he began to get genuine knowledge on a large scale. The process went faster and faster; it snowballed. Now he has to face the fact that the edifices of supposed knowledge, with which he has for so long buttressed and supported his attitudes, will no longer stand up, and, at the same time, he has to recognize that pure knowledge is neutral as regards his aims, that it has no direct bearing upon what he should feel, or what he should attempt to do.

We cannot quote further in illustration of the point of view which Mr. Richards adopts but we look forward to the appearance of his new book, "Science and Poetry," to be issued by the W. W. Norton Publishing Co. (New York) sometime during the current month and suggest it for the summer reading list.

[1] "Science and Poetry," *The Saturday Review*, **2**, 833–4 (June 5, 1926).

RADIUM

D. C. BARDWELL, FIXED NITROGEN RESEARCH LABORATORY, WASHINGTON, D. C.

Introduction

The biography of a great man is a history of the period in which he lived. In the same way, a discussion of radium must include the relations between it and its parent and descendant elements. These relations have contributed largely to the present-day theory of atomic structure and in turn the atomic theory thus evolved has predicted phenomena in the field of radio-activity which have later been confirmed experimentally. The various postulates and experimental facts which have contributed to the field of radio-activity are so numerous and have made their appearance in such rapid succession since the discovery of radio-activity and radium that it is impossible to give a chronological development. Only a brief account of the discoveries of radio-activity and radium will therefore be given, following which the subject will be presented upon the modern conception of atomic structure. The chemical properties of radium are discussed quite fully by Dr. Chas. H. Viol in his account of the production and uses of radium.[1]

Discoveries of Radio-activity and Radium

Before 1896, only two elements (thorium and uranium), of the groups which were later found to be radio-active, were known. The chemical properties of these elements had been established, placing thorium in the fourth group and uranium in the sixth group of the periodic table, respectively. These elements are quite abundant in the earth's crust. Compounds of these elements are not changed in measurable quantities in the time interval of centuries. It should be pointed out here that the chemical properties of even the more active radio-active elements are not in any way related to the property of "radio-activity." Thus, chemical reactions would not have led to the discovery of anything peculiar to these elements.

The discovery of X-rays by Röntgen in 1895 had stimulated a search for sources of this penetrating radiation, other than the vacuum-tube discharge. During this same period, considerable interest was shown in the study of the phosphorescent property of certain minerals. Since X-rays excite phosphorescence in many of these substances which phosphoresce after exposure to light, Professor Poincare suggested that this phosphorescence might be connected with the origin of X-rays. Accordingly, Professor Henri Becquerel placed a crystal of the double salt of potassium and uranium sulfate upon a photographic plate, the latter having been wrapped in heavy opaque paper. A distinct photographic record was obtained. The results of these experiments were announced at a meeting of the French

[1] To appear in the July number of THIS JOURNAL.

Academy on February 24, 1896. Later experiments showed that the penetrating radiation of uranium was in no way connected with its phosphorescence. The radiation was constant over long periods of time and was not dependent upon previous exposure to light or heat. These experiments marked the discovery of radio-activity.

Pierre and Mme. Curie made a quantitative study of the radiation from various uranium minerals and synthetic compounds and found that if pure uranium salts were prepared, their activity was proportional to the uranium content. This indicated that the radiation was an atomic property not affected by chemical combination.

In apparent contradiction to this observation, an examination of uranium minerals disclosed the fact that they are in many cases more active than would be predicted from the uranium content. This suggested at once that these minerals might contain other constituents more active than uranium. A systematic chemical separation of the elements of pitchblende by the Curies yielded two active materials, one associated with bismuth precipitated as sulfide, and the other associated with barium. The former was given the name "Polonium" in honor of the country of Mme. Curie's birth. The latter was named "Radium." In the pure state, radium is three million times as active as uranium and yet its activity is nearly constant over the period of a man's life. It is the "key" element of the radium family of radio-active elements. Some of the aspects of radium radiations have accorded full sway to speculation as to the vast energy stored in atoms which we may sometime find the way to release. For the chemist, however, the most interest is attached to the contributions to atomic structure made by studies in this field. Three properties of these substances were to be explained: (1) the radiations blackened a photographic plate, (2) they made air a conductor of electricity, (3) they excited certain materials such as special zinc sulfides to phosphorescence. In the years 1902–1903, Rutherford and Soddy proposed the disintegration theory of radio-activity as follows:

"The atoms of radio-active elements disintegrate giving rise to a new element, which may or may not disintegrate as did its parent. The atom resulting from the disintegration of the parent has different chemical properties than the parent. The disintegration is accompanied by corpuscular emissions and radiations, which afford a comparative measure of the rate at which disintegration takes place." This theory not only accounted for all the known facts at that time, but it made possible predictions which were later proved correct.

The Rutherford-Bohr Atom

The most generally accepted model of the atom is that of a miniature solar system in which the positive nucleus occupies the place of the sun

and revolving or oscillating about this nucleus are planetary electrons. The nucleus is very small in diameter (10^{-12} cm.) compared to the diameter of the atom (10^{-8} cm.). The nucleus contains the mass-giving constituents of the atom. It must also contain net positive charges equal to the number of electrons revolving about it. That the nucleus itself contains electrons is evidenced by the emission by some elements of beta rays (high velocity electrons) from the nucleus. The lightest element, hydrogen, consists of a nucleus of one unit of mass with its one net positive charge and one electron revolving about it. The helium atom consists of the nucleus, of mass four with two net positive charges, and two electrons revolving about it. The element lithium has a nucleus with average mass of seven and three planetary electrons. Passing to the heavier elements the net positive charge of the nucleus is greater and correspondingly there are more planetary electrons. The atomic number of an element is equal to the number of planetary electrons which, of course, is equal to the net positive charge of the nucleus. The electrons are apparently most stable in arrangement when in groups or shells of two, eight, eighteen, and thirty-two. Various periodic relations between the elements are made clear by these groupings. The discussion of these relationships would be too extensive to consider here.

Returning to the subject of atomic number let us picture the atoms of five radio-active elements. Radium has an atomic weight of 226 and its atomic number is 88. Radon (formerly designated as radium emanation) has an atomic weight of 222 and its atomic number is 86. Radium A has an atomic weight of 218 and its atomic number is 84. Radium B has an atomic weight of 214 and its atomic number is 82. Radium C has an atomic weight of 214 and its atomic number is 83. Radium disintegrates into radon; radon into RaA; RaA into RaB; and RaB into RaC, respectively. Inspection of the atomic weights of these elements will disclose that the first three transformations are each accompanied by a loss of four units of mass, and the atomic number decreases by two for each step. The transformation of RaB to RaC is not accompanied by a change in mass, but the product is one unit higher in atomic number. These changes will be clear after we consider the two types of corpuscular emission accompanying radio-active disintegration.

Alpha and Beta Particles and Gamma Rays

An alpha particle is the nucleus of a helium atom having a mass of four and a net positive charge of two. It is projected from the disintegrating atom with an enormous velocity (about one-fifteenth the velocity of light). Individually it is the most energetic object known. It plows through other atoms, in some cases knocking off an electron from 200,000 atoms (ionizing them), before its energy has been reduced to that of normal atoms.

A beta particle is an electron emitted in some cases with a velocity exceeding nine-tenths the velocity of light. It, too, plows through atoms robbing them of electrons (ionizing them). Beta particle emission is usually accompanied by an electromagnetic disturbance whose wave-length is exceedingly short, even shorter than X-rays. Such rays are very penetrating and produce ionization in the medium which they traverse by ejecting high velocity electrons from some of the atoms, these electrons in turn ionizing other atoms. These electromagnetic rays are designated as gamma rays.

Radio-active Transformation and the Displacement Law

When the radium atom disintegrates, an alpha particle is emitted carrying a charge of two and a mass of four. Thus the resultant atom (radon) has two less excess positive charges in the nucleus and four less units of mass. Thus we have radium with atomic number 88 and atomic weight 226, forming radon with atomic number 86 and atomic weight 222.

Radium B emits a beta particle carrying one negative charge but negligible mass. Thus Radium B having atomic weight 214 and atomic number 82 gives rise to RaC with the same atomic weight 214 but one unit higher in atomic number 83. In general, an alpha particle emission results in a product four units less in mass and two units less in atomic number. A beta particle emission results in a product of the same mass but one unit higher in atomic number. These two relations are known collectively as the displacement law of radio-activity.

Since the products of such disintegrations have different atomic numbers, the number of planetary electrons is also different. The chemical properties are correspondingly different. Radium is the heaviest member of the second group of the periodic table. Upon disintegration it emits an alpha particle. The resultant atom of radon is thus the heaviest member of the noble gas group. RaA and RaB are correspondingly members of the sixth and fourth groups, respectively. RaB upon disintegration emits a beta particle and the resultant atom of RaC is one unit higher in atomic number and therefore belongs to the fifth group. These relations have been completely verified by the chemical properties of the members of the radium series, the thorium series, and the actinium series.

Isotopes

The displacement law predicts that the net result of an alpha-ray disintegration and two beta-ray disintegrations is zero change in atomic number. The final element will have chemical properties identical with the original, although its mass is less. Such elements have been given the name isotopes. RaB, RaD, RaΩ, and ordinary lead are isotopic although their masses are, 214, 210, 206, and 207.2, respectively. Separation of these

elements, after mixing them, can only be effected by methods which depend upon a difference in mass, or by the radio-active decay of the shorter lived members. A study of non-radio-active elements has disclosed that many are mixtures of isotopes varying in mass by one or two units.

The Law of Radio-active Decay

In the postulates of the Rutherford-Soddy disintegration theory of radio-activity, it was stated that the disintegration of an atom was accompanied by radiations and corpuscular emissions which afford a comparative measure of the rate at which disintegration takes place. A quantitative study of the radiations led to the simple law that the number of atoms of a radio-active element disintegrating per unit time is proportional to the number of atoms of that element present. This may be stated mathematically as:

$$-\frac{dN}{dT} = \lambda N$$

when N is the number of atoms present and λ is the proportionality factor for the rate of decay. This factor is characteristic for each element and is not affected by temperature or pressure within the large range in which it has been tested. Integration leads to the expression:

$$N = N_0 e^{-\lambda t}$$

which means that starting with N_0 atoms of a radio-active element, the number of atoms N remaining at a later time t is given by $N_0 e^{-\lambda t}$. If now we wish to compare the lives of various elements, it is convenient to compare the times in which the number of atoms is reduced to half the initial number. This time is known as the "half life" of the element.

We may now return to a more detailed discussion of why some radio-active elements are present in the earth's crust in large quantities and others cannot be identified except by their radiation characteristics.

Radium has a "half life" of 1690 years. Radon has a "half life" of 3.85 days. It is obvious that if we started with the same number of atoms of each of these elements, the radon would have practically all disintegrated before one could detect any loss in the amount of radium. Looking at it from another standpoint, it would take a very small amount of radon to give the same number of alpha particles per second as that given by one gram of radium. We may consider (relatively) that the disintegration rate of radium is constant over a period of a few months. As a result of its decay, radon atoms are being generated at a constant rate. But the radon atoms are disintegrating at a rate proportional to the number present. In a month radium has generated enough radon atoms that the latter are disintegrating at the same rate as they are formed. This state is radio-active

equilibrium. The amount of radon in equilibrium with one gram of radium is only $^{6}/_{1000}$ mg. The parent of radium through ionium is uranium. In primary uranium ores where the radium formed has not been removed, radium is in equilibrium with its parent. In this dynamic state the ratio of weights of uranium and radium is about three million to one. Thus consideration of the lives of the various members of the radium family shows clearly why uranium is quite abundant compared to radium. It is clear, too, that substances with a half life of less than a few years are only temporary sources of radiation which must be replenished from the parent. The value of radium is due to its life which is long enough that its radiation may be considered constant over a century, yet its life is sufficiently short that small quantities of it are exceedingly active. Radium itself is an alpha ray emitter, but when sealed in a tube so that the radon generated is confined, it comes to equilibrium in a month with the after products: radon, RaA, RaB, and RaC. The beta-ray transformation of RaC is accompanied by very penetrating gamma rays. It is these gamma rays that are used in the therapeutic field. Since RaC is the gamma-ray emitter, radon (a gas) can be removed from radium and in four hours it will be in equilibrium with RaC. The radium may be kept in a safe in the laboratory and only tubes of radon need be taken to the clinic.

Conclusion

Only a few of the outstanding relations of radio-activity to chemistry have been touched upon in this article. New and important atomic relations are being evolved by intensive study in this field at the present time. One of these is the study of the beta-ray spectrum of beta-ray emitters, which has given evidence that quantum dynamics are applicable to the nucleus as well as to the planetary electrons of an atom. Are not these relations more interesting, and even more romantic than a discourse on how many battleships could be lifted a meter by the energy evolved during the disintegration of a small quantity of radium?

Potatoes Shown to Be Good Vitamin Source. The lowly spud is an important source of vitamin B—the antineuritic vitamin, whose lack causes the disease known as beri-beri. According to F. J. Lyman and Inez Blystone of the Laboratory of Applied Chemistry at Ohio University, this essential constituent is distributed about uniformly throughout the potato and is stable both during cooking and storage. Measured in calories, the white potato furnishes about twelve per cent of the American dietary.

Mr. Lyman and Miss Blystone have conducted a series of experiments in which they have found that rats thrived and grew at a normal rate on a diet containing as much as eighty per cent potatoes. When put on a diet of only forty per cent potatoes from which other foods containing vitamin B were excluded, the rats showed a rapid decline in condition which disappeared as soon as a sufficient quantity of vitamin B was again supplied.—*Science Service*

FRAGMENTS RELATING TO THE HISTORY OF CHEMISTRY IN AMERICA

Edgar F. Smith, University of Pennsylvania, Philadelphia, Pennsylvania

Fragment I

The interest of early American chemists in their science is made apparent in many ways. Proofs of this are constantly coming to light. Not long ago, a copy of "The Life of Dr. Lyman Spalding" came to my desk. He had studied chemistry under Dr. Aaron Dexter, of Harvard; at least he had "paid him $14 for a chemistry ticket." He became co-founder with Dr. Nathan Smith of the Medical School of Dartmouth College.

DR. LYMAN SPALDING

Spalding was intensely interested in chemistry, which he taught in the school. Finding that text-books on the nomenclature of the materials needed for experiments were obsolete, he discovered a French work, translated it and published it under the title of "A New Nomenclature of Chemistry" based on treatises by Morveau, Bertholet, and Monge.

The preface reads:

To the Students of Chemistry
at
Dartmouth College

Gentlemen:

In chemical pursuits, you are soon arrested by the many difficulties that arise from the introduction of a new language, and from the multiplicity of synonymous terms.

Impressed with the importance of that branch of science which you are pursuing, and ardently wishing to forward your acquirement, I have been prevailed upon so far to amend and make new additions to the New Nomenclature of Chemistry, as to adapt it to the present state of the science.

This sheet is inscribed, as a guide to the young chemist, by

The Author.

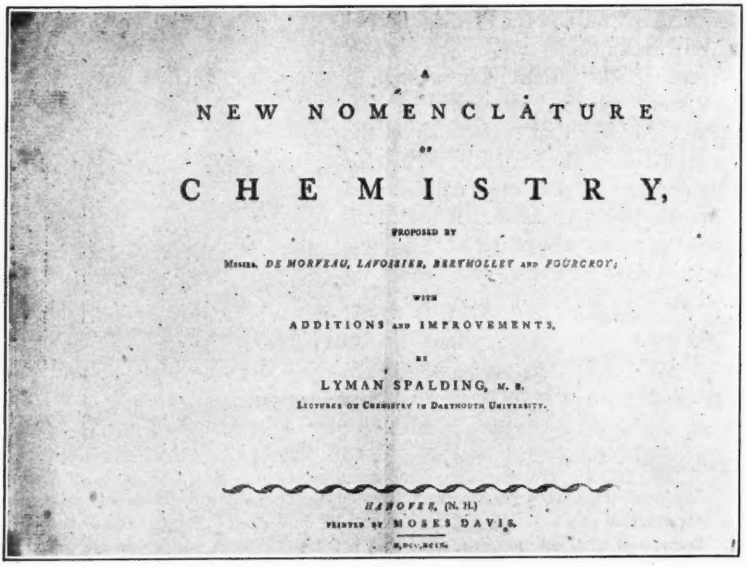
The "Nomenclature" was a student's manual of twenty pages, printed on rough, brownish paper about twelve by ten inches in size, the pages being divided into four columns, with the new names of chemicals placed opposite the former names.

The publication of this leaflet was well-received, and brought to Spalding considerable reputation.

It must not be forgotten that it was prepared away back in 1799! I held a copy of the "Nomenclature" in my hands a long time—thinking—thinking of chemistry in the dim past and of chemistry in the present. Such little scraps from by-past days are genuine treasures. They are a credit to the American "Fathers of Chemistry."

Fragment II

The coming of Joseph Priestley in 1794 to America is well-known, but scattered about in scientific literature occur strange statements;



A
NEW NOMENCLATURE
OF
CHEMISTRY,
PROPOSED BY
MESSRS. DE MORVEAU, LAVOISIER, BERTHOLLET AND FOURCROY;
WITH
ADDITIONS AND IMPROVEMENTS,
BY
LYMAN SPALDING, M. D.
LECTURER ON CHEMISTRY IN DARTMOUTH UNIVERSITY.
HANOVER, (N. H.)
PRINTED BY MOSES DAVIS.

Title page of Spalding's "New Nomenclature."

thus, in *Les genies de la science et de l'industrie*, Paris, 1870, the author, Benjamin Gastineau, carelessly writes,

> Joseph Priestley, exiled to America, became the friend of *Jefferson Davis!*

While in Gabriel Desclosieres' *Biographie des grand inventeurs dans les Sciences*, etc., the author says of Priestley:

> It was in the sumptuous residence of the noble Lord (Shelburne) that the celebrated chemist died in 1804.

And in *Essai sur l'histoire de la chimie*, Henri Gautier, Paris, 1837, one may read:

> Priestley fled for refuge to N. America, not finding the repose desired even in the remote sources of the Usquehannah, he sought an asylum among the Red-skins, and finally he and his entire family died by poison!

Fragment III

It is well-established that in America—in the New England Colonies—were men who practiced the art of transmutation (projection) of metals. They were alchemists in the fullest sense. Among them were the Winthrops (John)—father and son, but particularly the younger man. Ezra Stiles, of Yale, wrote that men of this class lived in and about New Haven. He further declared that Dr. Franklin had written him of alchemists "in these parts," meaning Philadelphia and its neighborhood. They have been sought, and in an early issue of the "Register of Pennsylvania" it is recorded that among those devoted to the occult sciences was Dr. Christopher de Witt, who was born in England, 1675, and came to America in 1704. He was a skilful physician and learned man, a reputed *magus* or diviner, or in grosser terms—a *conjurer*, a student and believer in all the learned absurdities and marvellous pretentions of the Rosicrucian philosophy. He translated into English poetry the hymns of Kelpius, the Hermit of the Wissahickon. He owned and dwelt in a large house, since his day the property of the Rev. Dr. Blair. He left all his property to strangers by the name of Warmer, saying they had been kind to him on his arrival in bestowing upon him a hat in place of his, lost on shipboard. He was an astrologer, a crystal gazer and a transmuter, living near Philadelphia.

Fragment IV

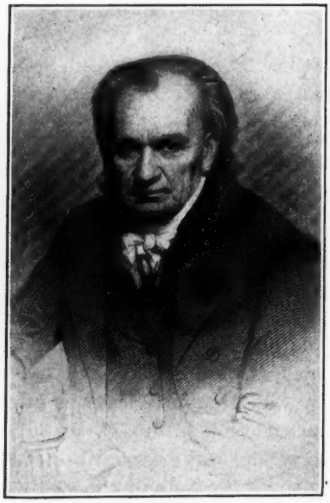
In leafing over the pages of the *Boston Journal of Philosophy and the Arts* for the year 1824, it was noticed in Vol. I, p. 390, that John W. Webster, in discussing a green feldspar from Beverley, Mass., said his object in submitting the green feldspar to a chemical examination, was to ascertain the proportion of alkali it might contain. For this purpose 100 grains, reduced to an impalpable powder, were mixed with twice their weight of boric acid, as proposed by Sir Humphry Davy (*Philosophical Transactions*, 1805; Davy's Collected Works, Vol. 2, p. 304). The material, after fusion in a platinum crucible, was digested in dilute nitric acid. "After separating the silicious earth the bulk of the solution was reduced by evaporating, supersaturated with carbonate of ammonia

and boiled; after filtration, nitric acid was added to the liquor which was again filtered and exposed to a temperature sufficient to decompose the nitrate of ammonia that had been formed. The salt finally obtained was nitrate of potash and weighed 23.6 grains, equivalent to 11.1 grains of alkali."

Here, it is quite evident, boric acid was used as a flux in silicates containing alkalis, about 75 years before Jannasch (*Ber.*, **28,** 2822 (1895); *Z. anorg. allgem. Chem.*, **12,** 208) made the suggestion, apparently as a new thought and elaborated the method. Another interesting feature of Webster's paper is that he credits this method to Sir Humphry Davy, whose communication antedates that of Jannasch by ninety years. The title of Davy's paper was: "On a Method of Analyzing Stones Containing Fixed Alkali, by Means of the Boracic Acid." For this paper and another entitled, "An Account of Some Analytical Experiments on a Mineral Production from Devonshire, Consisting Principally of Alumina and Water," Davy received the Copley Medal in 1805. This last mineral was Wavellite. Davy proposed the name hydrargyllite for it. He was ignorant of its phosphoric acid content, which was discovered later by Fuchs.

Fragment V

Amos Eaton wrote a small book entitled "Chemical Instructor" in the first quarter of eighteen hundred. It passed through several editions, although in its earliest forms it was called *Chemical Note-Book*.



AMOS EATON

The prefaces are interesting. Thus, in that of the second edition, Eaton says:

> All experiments are described precisely as I have frequently performed them; and as I have often caused them to be performed by students in my presence.
>
> The whole object of my course of instruction being the practical application of science to the common concerns of life, I give no experiments on rare, doubtful or useless substances.....and avoid, as far as possible, all hypotheses of a merely speculative kind.
>
> The valuable works of Thompson, Ure, Brande, Murray, Accum, Henry, Davy, Gorham and others; and the smaller works of Cotting, Cutbush, Comstock, &c. together with the translations of Lavoisier, Fourcroy, &c. as well as the essays and editions of foreign works, published by Silliman, Cooper, Hare, &c. must all

be contained in the library of the thorough chemist. But I venture to assert, that anyone, or all, of these works will not form even a tolerable guide for a course of chemical experiments adapted to the wants of a farmer, the mechanic, or the housekeeper.

It is to be much regretted, that most of the latest celebrated treatises on chemistry have so large a proportion of their pages devoted to those useless compounds, which can never profit the scholar nor the practical man.

Eaton was quite convinced that he was pursuing the proper course in order to popularize the science. He was engaged among the "common people." He was carrying the science out into the towns, villages, hamlets, and into the free, open country.

At another place he refers to an inquiry often made concerning his "Chemical Instructor." Here is the inquiry:

Since this little book is intended for schools and the popular class-room only, and has never been noticed in any public journal, why are more copies of it sold than of any other work on the subject of chemistry, published since it appeared?

The reply Eaton invariably gave to such inquiries was an extract from a letter, "written by the frank, ingenuous professor of chemistry in one of our learned institutions." As it has a suggestive explanation of the straightforwardness of Eaton, it is appended:

I will thank you to request Messrs. Websters and Skinners to send me three dozen "Chemical Instructors." For, like the professors of many of our public institutions, tho' Thompson, Brande, Henry, Gorham, Davy, Murray and other large books with great names, are set forth as text-books, I conduct my lectures and give my experiments, according to your directions. Tho' I do not *acknowledge* myself dependent on this duodecimo of 260 pages; yet it is my only safe guide for experiments; I intend now to put it into the hands of every student—

And a professor in another public institution said:

I should not be able to go through with the labor of a course of chemical experiments, on account of my feeble state of health, had you (Eaton) not, by your simple method described in the "Chemical Instructor," so greatly reduced the labor of preparation.

Eaton was an enthusiastic student of science. He knew minerals, he botanized and geologized and wrote in a popular way on these subjects. His books are highly entertaining to modern followers of science. He did good by his aggressive, enthusiastic method of imparting his knowledge.

In the preceding lines one observes that his chemistry, for example, was hailed as a simple expositer of chemical experimentalism—yet in examining his instructions to the student about to perform experiments there came the feeling that Eaton's directions must have required his personal presence when students were at work, or else the boys and girls of one hundred years ago were exceedingly clever and penetrated rather obscure instructions. It would be interesting to have a high-school teacher follow out some of Eaton's directions and await his or her comments.

In discussing nitrous oxide, Eaton said:

> Several persons have lately employed themselves in peddling this gas about the country, who call their vulgar frolicks, lectures on chemistry. All sensible citizens ought to discountenance such gross outrages upon decency, which tend to reduce the science to the level of a puppet-show.

Again, in discussing arsenic, arsenious acid, etc., Eaton, speaking of the "Medical Jurisprudence" of Dr. T. Romeyn Beck, from which he had drawn great help, compliments his friend, the author, in this way:

> I take the liberty to add that no physician, lawyer or judge, who has any respect for his own reputation, or for truth, ought to undertake any investigation where human life or liberty is concerned, without studying that work.

When all has been said there remains the fact that Amos Eaton was a pioneer in the teaching of chemistry. His labors introduced others to its beauties and to its utility, while to himself it brought vast consolation in its value to human kind. Eaton was in his early years a blacksmith. By heroic, self-sacrificing efforts he succeeded in entering Williams College, from which he graduated with the class of 1799. For years he was the senior teacher in the Rensselaer School at Troy, N. Y. Chemists of the present day are his debtors.

Fragment VI

The Pennsylvania Magazine, or *American Monthly Museum* magazine, was first published in January, 1775, by Robert Aitken. The celebrated Thomas Paine, author of *Common Sense,* etc., was one of the principal compilers and writers of the *Museum.* It was a work of merit; each number contained forty-eight pages, octavo, with an engraving. The war put a period to it July (1776).

The following story is of considerable interest. Aitken contracted with Paine to furnish, monthly, for this work, a certain quantity of original matter; but he often found it difficult to prevail on Paine to comply with his engagement.

On one of the occasions, when Paine had neglected to supply the materials for the magazine, within a short time of the day of publication, Aitken went to his lodgings and complained of his neglecting to fulfil his contract. Paine heard him patiently and coolly answered, "You shall have them in time." Aitken expressed some doubts on the subject and insisted on Paine's accompanying him and proceeding immediately to business, as the workmen were waiting for copy. He accordingly went home with Aitken and was soon seated at the table with the necessary apparatus, which always included a glass and a decanter of brandy. Aitken

observed, "he would never write without that." The first glass put him in a train of thinking; Aitken feared the second would disqualify him or render him untractable, but it only illuminated his intellectual system; and when he had swallowed the third glass he wrote with great rapidity, intelligence, and precision; and his ideas appeared to flow faster than he could commit them to paper. What he penned from the inspiration of the brandy was perfectly fit for the press without any alteration or correction. (*Register of Pennsylvania*, Vol. 1, 1828, p. 178.)

And it was in this publication—*The Pennsylvania Magazine*—of which Tom Paine was the editor, that two articles relating to early chemical projects in this country appeared. The pictures tell the story.

1. The Process of Making Boiled Salt (Fig. 1).

The water in full tides is received through the sluice No. 4 into the reservoir No. 5 (which is a hundred feet long and 40 broad), where it stands in the sun to evaporate to a pickle; thence it is pumped into a refining cistern, there to refine; thence it is drawn into the pans (which are made of plate iron rivetted together, about ten feet square, and twelve inches deep) there boiled and skimmed as the salt makes; then carried to the hot-house to cure, and from thence to the store.

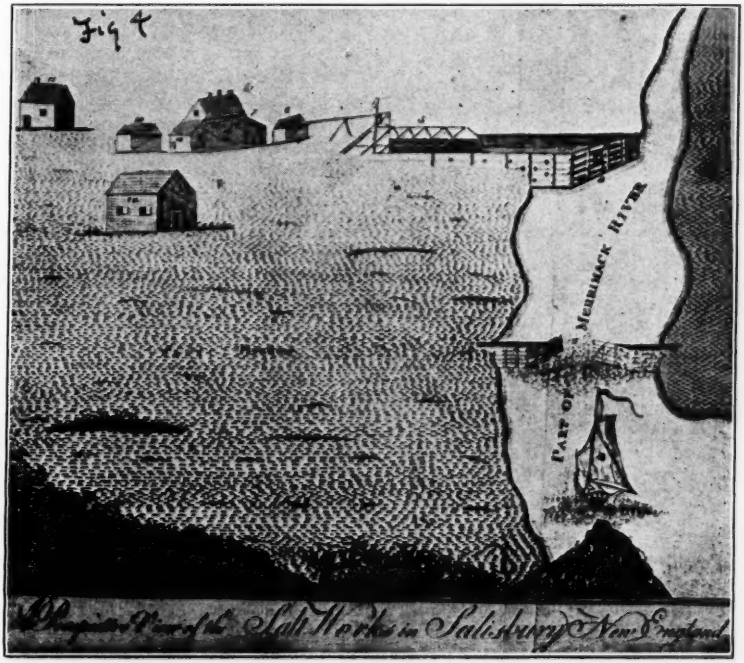


FIG. 1.

Explanation of Fig. 4:

1. Hook's rock.
2. The dam.
3. The wharf.
4. A sluice.
5. The reservoir.
6. A refining cistern.
7. A boiling house.
8. Hot-house.
9. Boiling house.
10. Refining cistern.
11. Dwelling house.
12. The store.
13. Salt boat.

The above account was handed to us by a member of the Hon. Continental Congress (January, 1776).

2. Description of a Furnace for Obtaining Sulfur by Distillation.

Explanation of Fig. 2:

Fig. 1. A traverse section of a furnace, in which sulfur is obtained by distillation from pyrites. It has eleven tubes, one of them is here represented lying across the whole breadth of the furnace. They are open at both ends. At the larger end the mineral is to be introduced; then close it with an earthen stopper. The small end opens into a cast iron receiver, which receives the melted sulfur. To prevent the crude mineral from passing into the receiver a star-like piece of baked earth is placed in the neck or small end of the tube. The length of the furnace, with eleven tubes, is much greater than its breadth. The tubes are about four feet long, somewhat of a conical form, six or eight inches wide at the larger end, and three-fourth of an inch at the small end.

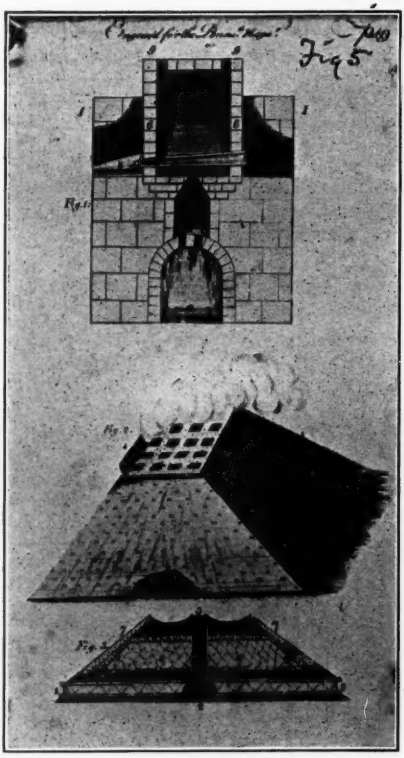


FIG. 2.

1. The walls of the long sides of the furnace.
2. The ash-hole.
3. The grate, made of bricks.
4. The fire-place.
5. The passage of the flame to the upper part of the furnace.
6. The two walls of the long sides of the furnace, which support the tubes.
7. A tube placed across the furnace. The tubes are of earthen ware.
8. A square cast iron receiver.
9. Two holes in the roof of the furnace, through which the smoke escapes. They

are generally ten or twelve inch holes in different parts of the roof, some of which are occasionally closed.

Fig. 2. Represents a quantity of ore (of lead or iron or other ore) piled up to be roasted, as well for the common purposes of preparing iron or other ores for smelting, as to save the sulfur, so commonly lost by burning ores in the open air. This is a kind of charring of ore. It is remarked that at the iron furnaces in America the ore is not calcined enough. If this method is used, the ore will be better prepared for smelting and a considerable quantity of sulfur will be saved for market.

1. Two sides of the pile, all the sides of which are covered with small ore.
2. The upper part, where holes or cavities are seen, in which the sulfur of the ore is collected.
3. An opening, where part of the pile has fallen down, and in which the sulfur is seen dropping down.
4. A plank to keep off the wind.

Fig. 3. A section of the above pile.

1. The wood to make fire.
2. Some charcoal for kindling the fire.
3. A channel formed by a wooden tube or pipe.
4. The large lumps of ore.
5. Small ore.
6. Finer ore or dust of ore.
7. The substance called vitriol, that is, a half roasted ore powdered.

Even in the days when the fate of our forefathers as to country and independence was in suspense there were those who gave thought, effort, and time to their social welfare. Chemistry ministers to society in peace and in war.

Anti-Rachitic Vitamin Made in Laboratory. There is much yet to be learned about the curative powers of ultra-violet light, the rays of sunlight which cause sunburn. "It is certain," said Dr. Alfred Hess of Bellevue Hospital, in a recent talk before the American Philosophical Society in session at Philadelphia "that ultra-violet rays bring about a retention of inorganic salts in the body thus helping to maintain the bony structure." As a result of this function ultra-violet light rays, either produced naturally by the sun or artificially, have been found helpful in the treatment of rickets.

During and immediately following the World War, said Dr. Hess, rickets or its counterpart, the so-called "hunger osteomalacia or war osteopathy," ravaged the peoples of Central Europe, Austria, Germany, and Poland. This was due almost entirely to insufficient food. Had it been known then that this malady could be prevented or cured merely by exposure to sunlight, much suffering could have been avoided.

The calcifying properties of foods subjected to ultra-violet radiations, which have been successfully used to prevent various disorders of the bones, are due to the cholesterol or phytosterol they contain. As every cell of food so treated contains one or the other of these substances the wide application of this indirect use of ultra-violet rays is evident.

The anti-rachitic vitamin has actually been made in the laboratory artificially, Dr. Hess went on to say, by treating the chemical substance, cholesterol, with ultra-violet radiations. This has not been accomplished in relation to any of the other vitamins.—*Science Service*

CHEMISTRY, HEALTH'S TORCHBEARER*

JANET RIOCH, BUTLER COLLEGE, INDIANAPOLIS, INDIANA

Fear not to go where fearless Science leads,
Who holds the keys of God.

The "dark ages" of Medicine are past. A glowing torch lights up the path of her progress and the bearer of the torch is the genius of Chemistry. Centuries ago in the land of Egypt the first, faint spark was kindled, when chemicals were for the first time used as medicine. That spark, cherished by the alchemists of old, smouldered through the years. At last it burst into a tiny flame and glowed ever brighter as the science of chemistry developed. Now, the torch of Chemistry illumines the way towards the conquest of disease. Truly enough, there are shadows ahead; and the way is often rough, but Medicine with dauntless steps follows the gleaming torch.

JANET RIOCH

One of those whose clear vision pierced the gloom during the latter half of the nineteenth century was Louis Pasteur. He was a trained chemist and his piercing analysis solved problems that advanced the cause of Medicine, and Science in general, by many years. He showed in his magnificent work the dependence of the medical sciences upon chemistry. Robert Boyle was in a prophetic mood when he said, two hundred years before, that the man who could determine the nature of the process of fermentation would be able to account, in a large measure, for the phenomena of disease. Pasteur was that man. He overthrew the theory of spontaneous generation and incontrovertibly proved that specific "microbes" caused fermentation and putrefaction. One is aghast at the revolting description of the state of surgery at that time. Mortality following amputation was over sixty per cent; no one thought of disinfectants. Pasteur's early training as a chemist had taught him above all things to be exact. He performed convincing experiments to demonstrate the proposition that infection could come from the air or from the hands of the operator. It was the young Scotch doctor, Lister, who first undertook to test

* Prize-winning college essay on the Relationship of Chemistry to Health and Disease, 1925–26.

carefully Pasteur's proposition. He used carbolic acid (phenol) as a disinfectant and reduced the mortality after amputation to fifteen per cent! Pasteur's signal work on vaccination and immunization borders on the realm of bacteriology, but it must be admitted that his chemist's training, his thirst for truth, lay at the bottom of his greatest achievements.

Another genius that added fire to the flaming torch was Emil Fischer. He has been acclaimed as the greatest organic chemist of the latter generation. His monumental study of the chemical composition of carbohydrates and proteins has thrown light upon the entire problem of metabolism. "With an imagination tempered only by a splendid scientific training, an originality of mind which made a lasting impress upon every piece of work with which he was associated. . . .he gradually unfolded the mysteries that had enshrined the most complex chemical substances known to man."[1] Fischer's most outstanding work was on the structure and synthesis of proteins, those complex substances which have been a constant riddle to chemists and physiologists. Fischer's synthesis of certain proteins showed in a wonderful way how this may occur in the living organism. The specific nature of the enzymes and their action was another study of great importance which Fischer undertook. Few men have accomplished so much which has been of real value as this deep-thinking chemist.

Our gratitude should overflow to these great pioneers and to the host of others who have been unmentioned. It is fitting to pay tribute to their work, before turning our dazzled eyes to the brilliancy of present-day achievements.

Most startling to the general reader, although not necessarily most important, are the accounts of the amazing effects upon the human body of specific medicines. Years of experience taught mankind that certain remedies were good for certain diseases. It has remained for analytical chemistry to determine why this is so and for synthetic chemistry to produce these remedies in their purest form. Analytic and synthetic chemistry have not only refined our drugs and greatly increased their potency, but they have actually produced new substances never before formed in nature. These new drugs contain the beneficial qualities of the natural substances without the harmful ones.

It was known for years that cinchona bark was the specific remedy for malaria. Then chemistry showed that the bark contained twenty different alkaloids, only one of which was of value. This pure substance, quinine, was isolated and found to be an extremely powerful protein poison. Its action, however, is only on the malarial parasite. Synthetic chemistry

[1] Benjamin Harrow, "Eminent Chemists of Our Time," D. Van Nostrand & Co., New York, 1920.

is now trying to isolate its powerful destroying property in order to use it against any other microörganism.

Another wonderful improvement on nature is the refinement of the chaulmoogra oil treatment for leprosy. Leprosy up to the present day has been at once the most loathsome and the most hopeless of diseases. To linger on from year to year, an object of horror, dreaded by all, and yet suffering agonies that only death will relieve, such has been the terrible lot of the leper. To chemistry has come the honor and the privilege of showing the way towards cleansing the lepers and thus obeying the command of the Man, Who once stretched forth His hand to a victim of this dread disease, and said, "I will, be thou clean." A careful chemical examination of chaulmoogra oil showed that its therapeutic value lay in the presence of the fatty acids of the chaulmoogric series. The ethyl esters of these acids were extracted and it was found that hypodermic injections of the purified esters were of more benefit than the use of the oil itself. Treatment could also be carried on over a much longer time without the unfavorable reactions caused by the crude oil.

It has been my pleasure to see the wonderful change that comes over lepers during this course of treatment. Their listlessness goes, they brighten up and become active and begin again to enjoy life. In advanced cases little can be done except to relieve and lessen the suffering. In early cases, carried over a long course of treatment, hope of recovery is good. Up to the present time "cures" are not claimed, but the patients are released on parole and may never need to return to the hospital. It is not hard to imagine the joy springing, as a fountain, in the heart of the patient pronounced "free from every indication of the disease."

From the days of Lister, antiseptics have been developed and improved. Here chemistry shows the way. Again, in the broad field of anesthetics, chemistry has an almost unlimited opportunity for service. Ether was formed by Valerius Cordus, a tutor in Materia Medica at Wittenberg in 1540; but it was not until 1846 that the first operation was performed with its use. Had medicine in the old days been more ready to follow the lead of the laboratory, instead of scorn it, much human agony might have been spared. Chloroform was used far more than ether at first, but it gave way to the less harmful anesthetic. Careful regulation of the amount given is absolutely necessary; but often, especially with chloroform, the shock to the heart causes sudden death. It is for this reason that anesthesia has been looked upon as such a terrible, mysterious sleep, from which one may never awaken. Chemistry has ushered in the era of the local anesthetic. Few discoveries have brought more immediate relief to mankind than that of the efficient harmless local anesthetic. Cocaine, the natural product which is found in the coca leaves, is effective but very poisonous. The chemist tore it apart and resynthesized it without the poisonous portion

and called it novocaine—the invaluable local anesthetic. It was found that the blood washed away the injected substance and so anesthesia did not last. Adrenalin was injected along with the novocaine to contract the blood vessels. This made it possible to perform even major operations and the patient was saved the danger and the bad after-effects of the general anesthetic.

The isolation of adrenalin itself is one of the thrilling chapters of chemical history. No adventurous voyage of discovery, no exciting detective story can compare with the search for the active principle of secretion of the suprarenal glands. "The history of this drug bears proud testimony to the powers of chemical research in the present day. Though not much more than twenty-five years have passed since the search for this unknown substance began, not only has it been found, but its chemical constitution has been determined, and the final result is the synthetic production of a substance that is identical with the natural."[2]

The story of the isolation of thyroxin, the principle of secretion of the thyroid gland is one of deep interest. Here we see the years of painstaking research finally crowned with success. Thyroxin, the specific remedy for myxoedema and cretinism, was at last found! The function of the thyroid gland and its therapy will be discussed in a later section, but it must be said here that, with the isolation of thyroxin, accurate dosage has been made possible.

Let us pause a moment to think; of what is this marvelously constructed body of ours made, that it should react as it does to outside stimuli? What governs this intricate structure of cells that each one, in a normal state, carries out its functions with such precision?

The answer to these questions lies at the basis of the study of health and disease. Physicians are no longer overloading the system with the innumerable drugs of pharmacology. Rather they are turning to chemistry to find the explanation of the way in which the body reacts and how this reaction may be controlled. The chemist and biologist, working together in the great science of bio-chemistry, are steadily solving these problems. Chemistry leads the way. Biology can go no farther than the microscope, while chemistry dissects the very atoms themselves.

The chemistry of the blood presents a subject of intense interest both to the physical and to the physiological chemist. From earliest times the blood has been looked upon as the symbol of life. It forms the transportation system of the body and its constituents affect every cell. It is extremely important, then, that the blood be kept in a normal state. What is the normal state? This again, the chemist is called upon to determine. We look upon water as being practically neutral in its reaction. If the

[2] E. Poulsson, "Pharmacology and Therapeutics," Williams & Wilkins Co., Baltimore, 1923.

change in the alkalinity of the blood were as great as the difference between tap water and distilled water, the organism would instantly die. To counteract this possibility of change, the blood contains certain compounds which react with the entering substances in such a way as to maintain the normal alkalinity. The blood is thus an excellent "buffer" solution and is able to take care of all ordinary disturbances. In cases of disease, however, such as diabetes mellitus, severe nephritis, and food intoxication, these "buffer" substances are used up and acidosis results. This also occurs when the diet contains too much of the acid-forming foods, such as meat, fish, and eggs. A change in diet, with increased carbohydrates which give base-forming products, helps to correct the acidosis. The mystery of this life-giving stream becomes so clear, when chemistry explains, that we forget the years of accurate research which made this explanation possible.

The processes of life are ultimately chemical. Oxidation and reduction is one of the most fundamental physiological reactions. The process of respiration, we know, consists in taking in oxygen and giving off carbon dioxide. In pulmonary tuberculosis, the lung must have as much rest as possible. When both lungs are affected this is not possible. A regulation of diet in a large measure helps to lessen the amount of work the lungs have to do. It has been found that a high carbohydrate diet increases the amount of carbon dioxide to be given off by the blood. This makes more work for the lungs. If a fairly high protein diet is given, the patient does not require to breathe so deeply or so frequently to throw off the carbon dioxide.

The digestion and assimilation of foods is one of the most important and most complicated processes of the animal organism. Dr. L. B. Mendel throws out a challenge to the chemists of today, when he says that "the fundamental chemistry of the nutritive processes is scarcely understood in a single detail." At least we have progressed beyond the days when it was thought that there was but one nutrient principle, which was extracted from every kind of food taken into the body. This was the earliest conception. Then the chemist, William Prout (1785–1850), developed the idea that the "nutrient principles" belonged to three groups, the saccharine group, the oil group, and the albumin group. Another chemist, Mulder (1802–1880), studied the albumin group and gave the members of this group the name of proteins. This division of foods is accepted at the present time: fats, carbohydrates, and proteins. When these are taken into the system they undergo chemical changes which render them useful to the body as sources of energy, or for building up the tissues. The carbohydrates form the chief source of heat and energy and do very little toward building tissue. If an excess of carbohydrates is taken into the system, it is stored in the body as glycogen. The internal secretion of the pancreas, insulin, in some way influences this process. If, as in diabetes, the pancreas

is not functioning as it should, the sugar is released in the blood stream in such large quantities that serious illness results.

The fats are more concentrated sources of heat and energy. They are broken down to form fatty acids and glycerol and may combine with the proteins to build up body tissue.

The proteins, which are the most complex of the food substances break down to form amino acids. The cells use the amino acids brought to them in the blood stream to elaborate the proteins they require. It is of great importance to note that different proteins break down into different acids. Certain of these acids are absolutely essential to animal life and only certain proteins will supply them. Mendel has proved this by feeding rats on isolated proteins. In a certain experiment three young rats were fed on casein, gliadin, and zein, respectively. The rat fed on casein grew rapidly. The one given gliadin grew slowly. The one fed on zein lost in weight. In a well-balanced diet the various proteins are supplementary to each other.

The actual process of digestion is accelerated or "catalyzed" by enzymes. These substances are secreted by the digestive organs. Their chemical composition is not known, but it is thought to be chiefly protein in character. They are thought to be colloidal in form and to owe much of their catalytic action to this.

The body seems to be governed by a system of mysterious messengers, who pass unseen through the blood stream and deliver their messages at the right door. These messengers are known as hormones. They are secreted into the blood stream by the ductless glands. Experiments on animals and observations of thyroid diseases in humans have shown that the thyroid influences the metabolism of the body. In cases where the thyroid has degenerated or is removed, a very marked and truly terrible change comes over the organism. The individual becomes listless and idiotic, the skin dries and thickens, the hair falls out, the general metabolism is "slowed down." This condition is known as myxoedema, in adults. In children it is called cretinism. Chemistry has presented to medicine the synthetic hormone, thyroxin. When injected into the blood stream, in regulated amounts, it will cure victims of hypothyroidism.

Basal metabolism is the measurement of the heat produced by the body at rest and without food. The dosage of thyroxin can be quantitatively measured by its effect on the basal metabolism. This is invaluable in the treatment of thyroid diseases. It is also possible to determine the actual energy requirement for the individual. Under-nourishment, especially in children, lays the system open to attacks by disease. To keep the body in health, a sufficient amount of energy-producing and tissue-building food must be taken in.

It is a mistaken notion, however, to imagine that a person fed on quan-

titative amounts of pure fats, proteins, and carbohydrates will continue very long to live in health, or in fact to live at all. Experiments have clearly demonstrated that animals fed on pure substances fail to develop normally. Death regularly ensues. The remarkable results obtained in experiments have been proved by chemists to be due to a lack of certain "vital principles," the vitamins. The vast amount of research done on them is justified by the tremendous role they play in the metabolism of the body. When the vitamin A is missing from the diet, the animal loses weight, its resistance to disease is lowered. It develops a typical opthalmia; and atrophy of the thymus, spleen, pancreas, and heart follow. Paralysis and at last atrophy of the heart and other organs follow the omission from the diet of the vitamin B. Rickets is a "deficiency disease" caused by a lack of vitamin X. Scurvy follows an omission of vitamin C. Remarkable recovery follows the administration of the vitamin even in extremely small doses. Mendel very truly makes the following statement: "Bearing in mind that the pathological phenomena described are among the more obvious and unmistakable signs of disturbance, one cannot avoid the suspicion that numerous less obvious, but equally detrimental defects or deteriorations as yet undetected and undetermined may also occur in so-called avitaminosis." "Recent advances have failed entirely to disclose the nature of vitamins or the mode of their operation in the organism."[3]

Of intense interest to every chemist is the work being carried on now at Johns Hopkins University. A Japanese investigator, who recently died, claimed to have isolated one of the vitamins. His papers do not make it clear whether it was vitamin A or B. These papers on the investigation have been obtained by Dr. McCollum, who is now repeating the work with the hope of verifying the determinations and of actually isolating a vitamin.

The sick or convalescent individual requires vitamins to "stimulate metabolic processes." The difficulty we now face is in supplying the sick with known amounts of vitamins. Concerning the feeding of vitamins to patients Emmett says, "In short, recovery should then be more rapid and convalescence shortened by this procedure, all of which shows the relation of the vitamins—'the infinitely little'—to health and disease."[4]

Professor Louis Kahlenberg, in a recent address, pointed out in what a tantalizing way the plants carry on their functions. Their adjustments are so fine and they work so quietly. Yet we humans go at things in our "hammer and tongs" style and expect results. A close analogy may be drawn between the plant and the organism. If we knew how these "infinitely little" principles, the vitamins and hormones, acted we could con-

[3] L. B. Mendel, "Nutrition, the Chemistry of Life," Yale University Press, New Haven, 1923.

[4] A. D. Emmett, "The Vitamins and Their Relation to Health and Disease," Detroit, 1922.

trol the body in a wonderful way. There would be no need to drug the patient. Nature would be quietly and gently helped by the means she herself uses.

There has not been an attempt in this essay to cover the entire field of medicine, but in every branch chemistry is always the leader, the forerunner, the torchbearer. In an address entitled "First Get the Facts," Secretary Redfield said, "The mind of science is one of high ideals. It is a modest mind, for it recognizes that there are many things it does not know. . . .It is a practical mind, for it aims to find the hidden things of nature and put them to use. . . .The scientific mind, if it be true to itself, knows no passion, nor prejudice nor predilection, unless it be the passion for the truth that is not yet known."

This is the mind of Chemistry.

Distinct New Form of Chemical Compound Found. A new form of a chemical compound with properties varying widely from any of the other known forms is one of the scientific curiosities described at the meeting of the American Philosophical Society at Philadelphia.

Dr. John H. Muller of the University of Pennsylvania has shown that germanic oxide has at least two distinctly different forms, one of which is quite insoluble in water and inactive toward all the common acids and water solutions of alkalis. These properties are quite at variance with those of the usual form known to chemists.

Experimental work on the insoluble compound, designated for convenience the alpha form, has demonstrated that the pure soluble form may be completely converted into the alpha by a series of fractionations. Dr. Muller has found that this alpha modification has a density almost twice as great as any of the soluble forms and that when fused at a temperature about 1100 degrees Centigrade a more or less unstable glass results which is completely soluble in water.

X-ray spectrographic analysis of these various forms of germanic oxide undertaken by Dr. R. W. G. Wyckoff at the Geophysical Laboratory, Washington, D. C., has confirmed the assumption that the alpha phase is a distinctly new allotropic form of the compound. All the preparations of the soluble oxides aside from the fused glassy oxide are alike among themselves but differ from the alpha form in their diffraction pattern.—*Science Service*

National Academy Honors Norwegian. The National Academy of Sciences, at its annual dinner, awarded the Agassiz Medal, one of the highest honors in the gift of American science, to Prof. Vilhelm Bjerknes, of the University of Oslo, one of the foremost scientists in Norway. Prof. Bjerknes represents the second generation in his family that has worked on a single great scientific problem, for his father before him, Prof. C. A. Bjerknes, was a famous investigator of the physical properties of water and other liquids, and when he died he passed on his problem to his son, who has continued in the same field and made notable contributions which have had important results in the development of modern oceanography and meteorology as well as in the more purely theoretical physics of the laboratory.

The association of Prof. Bjerknes with American science is no recent thing. He has been an Associate of the Carnegie Institute of Washington for several years, and the relation has just been renewed for another period of three years.—*Science Service*

THE RELATION OF CHEMISTRY TO THE ENRICHMENT OF LIFE*

LA VERNE KERNS, TRENTON JUNIOR COLLEGE, TRENTON, MISSOURI

Behold, I bring you Good Tidings of
Great Joy which shall be to all people.

That is the mission of chemistry in the world. Great joy is the ultimate enrichment which it bestows upon life. Is life made more joyous by this science? Yes, from a more comfortable morning shave to warding off of death—even to things more vital than death—chemistry has enriched life. By being made longer and more worth the living, life has been enriched by this fundamental science of the transformation of matter; fundamental because it treats of matter; fundamental because it deals with the components of all things; fundamental because if any man, any place, writes down one hundred common nouns, a knowledge of chemistry is necessary to explain the making of every one of them.

LA VERNE KERNS

Chemistry is related to the enrichment of life in two widely different fields. One is the conquest and improvement of nature; the other, the formation of a new state of mind, a different mental attitude. The one is physical; the other, mental. The former is objective; the latter, subjective. Industry and medicine illustrate the former. The lover of truth, that careful, inquiring, measuring, testing, generalizing individual who follows facts instead of opinions and superstitions, is an example of the latter. Of course, development in the two fields has gone on together. One could not develop one without the other; and it would be difficult (perhaps, foolish is a better word) to attempt to say which has been more important to the enrichment of life. That's like deciding whether heredity or environment plays the more important part in the life of an individual. Man, being neither content with his adaptations to nor satisfied with his improvements on nature, has created new and more satisfactory products. In so doing he has, in the necessary chemical analysis and synthesis, discovered new truths which have freed his mind. Every new creation, and they are

* Prize-winning college essay, 1925–26.

many in spite of the cries of the theologian, is the product of chemistry; for, "It is the chemist alone who possesses the power of reducing a substance to its constituent atoms and from them producing substances entirely new." By examination of some of the chief agencies of the enrichment of life and by observing the relation of chemistry to them, we may be able to appreciate in a small measure the great bearing of chemistry on the richer life (a bearing inconceivable in the whole). Among the factors which distinguish the life of today from that of the past, as the richer and fuller, are: fire, metal, industry, communication, health, the open mind, the love of truth, and realization and appreciation. Let us take them one at a time and see the relation of chemistry to each.

Fire was the first important factor in making life more worth the living. To think of man without fire is impossible. It has been with him as far back as the neolithic age. Since fire is so old it cannot be a creation of chemistry, but it is the fire-making and fire-using abilities of man, developed and multiplied by chemistry, which have enriched his life. Neolithic man had fire, but it probably enriched his life no more than it scorched it. The great usefulness of fire lies in the multiple ways chemistry has applied it. Ancient man could not make it, did not understand it, therefore, worshipped it and used it meagerly. His natural fire probably came from volcanoes and lightning. Its sacred keeping was a religious custom even after he learned to make it by whirling one stick upon another.

At that point progress ceased until chemistry took a hand and ultimately created the match, an article having no counterpart in nature. It is a creation of chemistry which benefits all mankind, for a cent will buy a hundred and the child of six can use them. Since, by the science of chemistry, man has thus been able to harness nature in such a way as to command fire, let us see to what uses he has employed it. Man uses fire for light and heat. As a light producer, he had achieved in some 5000 years the flickering, smoking, foul-smelling torches, grease lamps, and candles. Then chemistry placed a chimney upon the lamp, and the flickering flame became a steady, brighter light. Later, by the chemical creations of gas and mantels and by chemistry's aid in harnessing electricity, the modern gas and electric lights were produced. As a heat producer man's fire was warm enough to burn his finger in summer and melt ice on a mild winter day. The chemist's fire is capable of the decomposition of water or even sand. From the warmth of the pine tree fagot to a white heat which cuts steel more readily than our bread knife cuts the baker's product is the work of the chemist. How this increase in the heat of fire has enriched life can be better understood after a discussion of metal, the second great factor in the chemistry of human progress. But let us remember of fire that it is a chemical change not a supernatural phenomenon, and that the chemist's understanding of it as a process of the fast addition of oxygen has made

possible the increase in man's fire-making and fire-using abilities to the present numerous and indispensable ways.

Metal is the second factor important in the enrichment of life. Man had some metals almost as long as he had fire, but they were few, impure, and expensive. Gold and copper were first because they were free or uncombined in nature. Then man's campfire was built where there were tin ores in addition to the copper, and he discovered a new metal, the alloy bronze. Later man became able to produce a little iron from its ore, but what a little it was. Everyone became iron misers then. By mixing carbon with the iron, steel was made, but I shouldn't want to live in the Woolworth Building if it had been built in that day. Before the age of chemistry, man possessed only these metals: gold, copper, tin, bronze alloy, iron, and steel. The iron could have all been used in Ford engines, and it was only guess-work steel.

Today, chemistry smelts the iron in the blast furnace, purifies it by efficient chemical means, and mixes the right amount of carbon with it to produce the best grades of steel. It is no guess-work now, but a cheap, efficient, precisely controlled, chemical process. Today we have iron to use the world around, and steel to use from earth to sky. Chemistry has added alloys of steel, each possessing properties and powers not possessed by the parent metals. Among them are manganese steel, chrome steel, tungsten steel, and nickel steel. Think of the ways iron and steel, in an abundance made possible by chemistry, have made the life of man more worth the living. No, do not think of them all; you need to think of other things in a lifetime. Iron and steel have made of life a new thing. We live in "the age of steel," "the age of power," "the age of machines," "the age of transport." Man, ever desirous of saving his energy, should merely have said, "the age of chemistry." Can you think of the world without all this? We would drop back to the pastoral age of Abraham and Isaac. Where 100,000,000 people now live, 5,000,000 could not then exist.

Besides iron, steel, and steel alloys, chemistry gives us molybdenum and tungsten to use in high-speed tool steels and in lamp filaments. Also chemistry has discovered and put to use calcium, magnesium, aluminum, platinum, radium, and uranium. Through radium a great truth has been revealed to chemists, that of atomic disintegration. So we see metals have done much to enrich the life of man and chemistry has had a great share in getting and using these metals.

The next step toward the higher life is industry. First and most fundamental is agriculture, concerned with the growth of plants and animals. Now since plants and animals are but chemical laboratories of nature in which are carried on many transformations, the relation of chemistry to agriculture is very close. Chemistry tells us what the plant feeds upon, discovers in what foods the soil is deficient, and tells us how to prepare and

apply those foods. Again, chemistry tells us the needs of the domestic animals and what plant foods contain those needs. Thus, the farmer may, thanks to chemistry, feed his plants and animals balanced rations. Thus chemistry has brought about "scientific farming." What this means is not yet realized in America, but it is fully appreciated in the old world and time will see its realization in the new. If the American always likes his white bread, he will some day learn to make scientific use of the chemically prepared fertilizers.

In the industry of manufacturing, chemistry again finds many duties. It has already been seen how essential chemistry is in the working of metals. In this indirect way it is also essential to manufacturing, for without an abundance of metals, manufacturing could not exist. This great industry demands engines, machines, and tools made of a quality of metal that only chemistry has enabled man to produce. Think of the ways engines, machines, implements, and tools serve man! Think of the ways chemistry serves man! It is employed by manufacturing in other ways than metal working.

Chemistry has its own industries. The making of high explosives and fertilizers from nitrogen, the making of coke, gas, and coal-tar products such as dyes, the making of synthetic perfumes and flavors, the making of paper and cloth, the making of celluloid, the making of rubber products, the making of glass, the refining of crude oil, the making of desirable foods from cotton seeds and vegetable oils, oleomargarin, crisco, and soy-bean oil are examples, the refining of cane sugar, the making of beet sugar, all these are only a few of the chemical industries.

That chemistry is fundamentally important to industry is shown by the large number of chemists employed outside their own industries. Every important organized producer has his chemical laboratory, where analyses are made of all products consumed or produced and where checks are made in every conceivable place to stop waste and increase efficiency. The superintendent of the St. Joseph, Missouri, branch of the Armour Packing Company told me that, "The checks in waste and increased efficiency in operation, which are due to the work of the chemical department, are responsible for a change from loss to gain in many a week's run." Chemistry, then, is also indispensable to industry. Manufacturing, as we know it today, is the result of chemical knowledge; also is scientific farming, and while much of farming is not yet that kind, the scientific farmer will be tomorrow's successful farmer.

The fourth factor in the enrichment of life is communication. The chief means is by print. Without the aid of chemistry, books and papers could be afforded by only two per cent of our population. Chemistry has enriched life by placing good books within the reach of all. Notice how much of the making of a book is within the scope of chemistry. A book

is printed with ink made by a chemical process, on paper made by a chemical process, by a machine made possible by a chemical process. If it contains pictures, they were taken on a film made by a chemical process, and the registry of an impression on the film was a chemical change. It was developed by a chemical process, printed by a chemical process, and transferred to a "half-tone" by a chemical process. The book is bound in cord produced by a chemical process, glued with a chemical glue to its back produced by a chemical process and dyed by a chemical dye. Even though it's a "Diamond Dick" novel, it's also quite a book on chemistry.

Other means of communication are the telephone, telegraph, wireless, and radio. All are made possible by the phenomenon of electricity. So chemistry bears upon them in all the ways that it bears upon electricity. Again, these are all made of delicate instruments, the production of which chemistry has made possible. All of them, but especially the radio, necessitate a knowledge of laws of nature which chemistry has revealed. Thus the detector and amplification tubes were made possible only by chemistry revealing some of the secrets of the electron. So, again in communication, we see how chemistry has enriched life. Communication seems to be one of the greatest factors in making life more worth the living, and it is chemistry which has put books and papers within the reach of all. It is also that same science which is permitting such an advance in radio. Who can predict the future influence of radio in enriching life?

The fifth factor, in the conquest of nature and the enrichment of life, is health. Personal health goes a long way toward determining the richness of the life of any individual. This health is dependent upon the laws of chemistry. The human body is a complex chemical laboratory. The changes which take place in it are chemical changes and are best explained and understood by the laws of chemistry. Life from beginning to end is the transformation of matter—the very thing with which chemistry deals. That is why this science is able to do so much toward health and the more enjoyable life, in so far as health is concerned. That is why medical schools require such thorough preparation in chemistry. Only the chemist can so minutely analyze the components of a healthy body as to discover what is necessary to preserve its health. With this knowledge only he can build up a product to fill that need. Thus if any organ of the body is functioning improperly the chemist can relieve the resulting ill health by supplying the product of the affected organ. Another way chemistry helps medicine is by supplying a specific substance to cure a specific disease. Chemistry has produced cures for leprosy, syphilis, and epilepsy in this way. A cure for pneumonia and diabetes seems nearing perfection, and in the future cures for tuberculosis and cancer will probably be worked out.

By analysis of foods the chemist assists greatly in keeping the body in health. He knows the percentages of different foods needed by the body

and what foods must be eaten to obtain those percentages. He can tell us when a food is pure, when it contains poison, or when it is spoiled. He can detect germs in food and water, and tell when any food becomes unsafe. Most everyone can appreciate the value of health, but the worth of life cannot be estimated. When we consider that chemistry has lessened the suffering of thousands, restored thousands of others to health, and saved the lives of not a few, then do we realize that the value of chemistry to the enrichment of life is unstatable.

Sixth of the factors of the life more worth living is what I have termed the open mind. This is the first of the subjective influences, and while it is true of other sciences it is especially true of chemistry as the most basic, underlying, and fundamental. The chemist, in his laboratory work, has developed an open mind. He looks for a definite result, but if unsuccessful sees meaning in the results obtained. He is on the alert for the whisperings of Nature which may reveal her secrets. He is ever watching and listening with all the powers of his open mind, ready to catch and to follow the smallest hint which may lead to the revelation of a secret. It is they of the open mind who, as Dr. A. D. Little said of the "Fifth Estate," "bring the power and fruits of knowledge to the multitude who are content to go through life without thinking and without questioning, who accept fire and the hatching of an egg, the attraction of a feather by a bit of amber, and the stars in their courses, as a fish accepts the sea." It is true that few possess the open mind for it is most difficult to achieve, but we, who stick so stubbornly to our convictions, ignorances, and superstitions, share its benefits.

Desire and discovery of truth is the next subjective factor. The whole life of the chemist is spent in search for truth. His love of truth makes him accurate and exact in all that he does. Knowing that in Nature there is no lie, but painfully exacting truth, his truth becomes the truthfulness of Nature. The scientist does not tolerate nearly, just about, almost the truth; but the truth, the whole truth, and nothing but the truth, so to speak. Great is his love of truth for to him, "The greatest and noblest pleasure which men can have in this world is to discover new truths; and the next is to shake off old prejudices" (Frederick the Great). Through the chemist's discovery of the truths of nature has come a great good to mankind. "The truth shall make men free" was a prophecy of that good. Science, by the discovery of truth, has freed the mind of man. He no longer fears and is superstitious but believes and is confident, for he sees the world in the light of natural laws rather than the darkness of magic. His is a mind filled with imagination, with admiration, with a sense of the beautiful. His is a mind which realizes and appreciates.

But realization and appreciation are other factors illustrative of the relation of chemistry to the richer life. Not until man learned some of the

truths of nature could he realize; not until he began to realize could he appreciate. The ignorant man thinks his knowledge self-sufficient; the genius realizes his is infinitesimal. A small boy who had just mastered the "Four Fundamentals" once said, "I've learned almost everything." Fifty years later, when he suddenly realized the inability of man to grasp the infinite, he exclaimed, "God, the littleness of the knowledge of man!" The theory of the complex composition of the atom has lent a wonder to the smallest of things which equals that possessed by infinity. It adds meaning to the phrases of Shakespeare: "Tongues in trees, books in running brooks. Sermons in stones, and good in everything." It also explains with some satisfaction a puzzle which troubled me greatly. As a small boy, I often heard sung the old religious song: "There's Honey in the Rock for You." Each time it struck a discord in my ideas of the harmony of things. Even some ideas of religion which I grasped as a youth did not quite justify it. But the truths of nature to which I am awakening make it clear. As truth after truth is learned, greater and greater becomes man's ability to appreciate. Do you see what this has to do with the enrichment of life? It has remade life. Science, and principally chemistry, has, by its knowledge and application of "the great and fundamental facts of nature and the laws of her operation," brought a dawning light to man. "It has extended the horizon of the mind until its sweep includes the thirty thousand suns within the wisp of smoke in the constellation of Hercules and the electrons in their orbits within the atom. It has read the sermons in the rocks, revealed man's place in nature, disclosed the stupendous complexity of simple things, and hinted at the underlying unity of all." This is what has freed man's mind; this is what has enriched life. I doubt that any man, however well he may have read his book of worship, can appreciate, fear, and worship God and realize his all-powerfulness (without a knowledge of the laws of nature) on a par with the scientist.

In attempting to discover the relation of chemistry to the enrichment of life, we have examined eight factors or agencies important in the improvement of life. These eight factors are: fire, metal, industry, communication, health, the open mind, the search and discovery of truth, and realization and appreciation—the last three being subjective factors. We have noticed the relation of chemistry to each of these, and while these are only a few agencies, they are general ones—ones from which we may safely draw conclusions.

Chemistry is the most fundamental, basic, and underlying science. It is the science of creation. It has a bearing upon all things. Man has been able to employ it to advantage upon every substance he knows. Chemistry more than any other word has been the means of attaining this height of civilization. Its truths have elevated man's mind from the dreary dungeon to the lighted peak. Dealing with the transformation of matter,

chemistry deals with change, and change is life. Studying transformation, chemistry is studying life. It seems that life is chemistry and chemistry is life. And as yet we have not mentioned the future. Almost all the accomplishments of chemistry have been in the last two hundred years, and most of those in the last century. Each new success broadens the field for the next. There seems to be no end. Discoveries are multiplying in geometric ratio. Man is in the dawning hour. Day does not come; yet dawn ceases not to grow brighter. Cushman in his book, "Chemistry and Civilization," has pictured the dawning and, while a prophecy of the future is beyond the powers of the imagination, his picture is inspiring. He says: "It is possible to believe that all the past is but the beginning, and that all that has been is but the twilight of the dawn. It is possible to believe that all that the mind has ever accomplished is but the dream before the awakening. We cannot see, there is no need for us to see, what this world will be like when the day has fully come. We are creatures of the twilight. But out of our race and lineage minds will spring that will reach back to us in our littleness to know us better than we know ourselves and that will reach forward fearlessly to know this future that defeats our eyes. A day will come, one day in the unending succession of days, when beings shall stand upon this earth, as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars."

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Iodine Known as Remedy Two Hundred Years Ago. Iodine as a preventative of goiter is not a new thing under the sun, according to Dr. Gilbert D. Harris of Cornell University. In *Science*, he quotes from an old Spanish medical work by an early French scientist, Boussingault, who wrote in 1825. In one place the author states that, "till now, iodine is the only specific known for goiter." Elsewhere he continues, regarding certain mineral springs in Colombia, "In the province of Antioquia no other salt is used, save that from these peculiar springs, whose waters I have analyzed and convinced myself that, though the composition of their salts is variable, there is in all an appreciable amount of iodine. Hence the reason that there is no goiter in Antioquia: each inhabitant takes every day a dose of iodine with the salt he consumes." Again: "It is a singular fact that for more than a century these waters have been recognized as a sure specific for goiter."—*Science Service*

THE RELATION OF CHEMISTRY TO AGRICULTURE*

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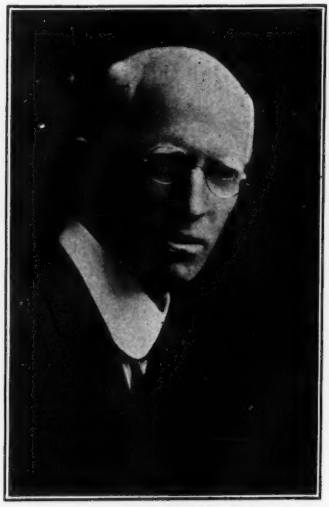
Appreciation of things at their true worth depends largely upon a reasonable knowledge of them on our part. People have lived next door to each other for years as entire strangers, when a better acquaintance would have revealed much of common interest. Nations of people have hated each other most ardently until, perhaps on the field of battle, each has discovered in the other most estimable qualities. Men have pursued occupations in discontent and near-failure until a more complete understanding of the craft has brought vision, success, and happiness. This idea of appreciation based upon knowledge is illustrated very concretely in the case of the radio. Already familiar in thousands of homes, both city and country, the radio has been the source of much real benefit in the way of entertainment. Many radio owners have little or no knowledge of the principles of radio operation and consequently esteem their machines but lightly. A good performance is enjoyed, but a failure to perform satisfactorily brings down a shower of maledictions upon the head of the poor radio. The real student, on the other hand, finds in radio a scource of constantly increasing wonder and amazement.



JAMES ARCHIBALD MCCRAE

So it has been with agriculture. Discontent and failure have been, to a large extent, due to the fact that in the past the farmers did not possess a knowledge of the scientific principles that underlie agriculture. The time was, in the days of our ancestors, when a large proportion, about eighty per cent in fact, of the population lived on the farms. Farm life being the prevailing manner of living, and supplying, as it did, the necessities of life, people in general were contented. They were good farmers, those ancestors of ours. They faithfully planted their corn and cured their meats "in the light of the moon." They tapped their maple trees when the south wind began to melt the snow and performed unnumbered other operations when "the signs were right," without stopping to wonder as to the why and wherefore. But times have changed. The fields have long since parted

* Prize-winning college essay, 1925–26.

with their virgin fertility. Industry has drawn upon the population until scarcely one-third of our people are on the farms. Financial depression, inadequate markets, and poor farming methods have combined in reducing the agricultural morale to a very low ebb. The ceaseless drift toward the cities is in part counterbalanced by the movement of land-hungry city dwellers to the farms, seeking to better their circumstances by entering upon an occupation in which they possess more faith than experience.

These would-be farmers are ready and anxious to learn everything that will promote their success in the agricultural venture, but farmers of long experience are skeptical about advice, especially from outsiders. Such an attitude is not surprising when one considers the numerous sources from which advice comes. The business man, the commercial club, the local newspaper, the county agent, inspectors, agricultural college bulletins, all presume to know more about the farmer's business than he knows himself. Undoubtedly a lot of this free advice is wasted whether good or bad, because the farmer, being "sot in his way" does not take kindly to being told what to do and when it must be done. Some of the advice given is undoubtedly erroneous, much of it is superfluous, but again valuable facts are presented which if utilized by the farmer will prove greatly to his advantage. The science of chemistry has a most vital relation to agriculture.

Here is the whole situation in a nut-shell. The whole business of agriculture is based upon, is dependent upon, the chemistry of plant and animal life. The plant foods in the soil are definite chemical compounds. The growth of plant and animal tissues, the processes of digestion, the production of energy or power are all chemical processes, as indeed is life itself. The husbandman who would handle his crops and his livestock with enjoyment and profit needs a working knowledge of chemistry as applied to his enterprise. One cannot hope to be an expert farmer and an equally expert chemist at the same time. Chemistry is a highly specialized science, and the chemist who possesses the true scientific spirit, which aims at promoting the best interests of humanity, can supply the farmer with facts and figures that will enable him to work out his own problems.

The work of the chemist is not widely advertised but its influence is far-reaching. The world of nature is a great laboratory in which constant changes are taking place in accordance with definite laws and principles In order to discover, verify, and use these laws and principles, the chemist must experiment under conditions which can be controlled or varied at will to produce accurate results. Therefore the chemist in his carefully arranged laboratory, surrounded by all the materials and equipment that he may require, carries on a work the results of which may reach to the ends of the earth and add wealth and happiness to humanity. Pasteur, in his laboratory in Paris, discovered facts regarding bacteria that have

revolutionized the world's concept of disease and of food preservation. Unceasingly the work of investigation goes on, achieving one triumph after another. Diseases are conquered, new processes of manufacture are developed, new and valuable substances are produced. In the field of agriculture the chemist has also achieved great triumphs. But the work of the agricultural chemist goes on day by day and week by week, solving the problems of individual farmers, problems of soil, of feeds, diseases, insect pests, or whatever may affect the well-being and the success of agriculture.

Some years ago a preacher was calling upon a prosperous farmer of his community who conducted his guest about the farm. Evidences of prosperity were everywhere and the farmer proudly proclaimed the unfailing productivity of his fields. The visitor asked:

"What means do you use to maintain the fertility of your land?"

"None," replied the farmer, "Why should I put expense and labor upon the land? The fertility is there. See what it produces?"

"But what provision are you making for posterity?" asked the preacher. And the farmer very greatly shocked his visitor by exclaiming:

"To hell with posterity!"

The exclamation of that farmer was evidently the unspoken thought of many in that fertile valley. Today the "posterity" are struggling desperately to subdue the foul growth and build up the impoverished soil that is their heritage.

Long before the age of chemistry it was well-known that the addition of certain substances such as barnyard manure, sea-weed, and leaf mold to the soil resulted in more abundant crops. It is even stated that the Indians learned that putting a fish in each hill made the corn grow better. Little or no attempt was made to explain this increase of fertility, or to determine the kind of fertilizer best suited to the needs of a particular soil.

The coming of the chemist gave intelligence and definiteness in the use of fertilizers. The elements comprising the plant foods were found to be comparatively few in number and to come from the air as well as from the soil and the water in the soil. Oxygen and carbon, in the form of carbon dioxide, being taken from the air by the plants, have not required much attention, but nitrogen, chlorine, calcium, potash, magnesium, iron, sodium, sulfur, phosphorus, and silicon, occurring as they do in compounds in the soil or dissolved in the soil water, are the elements, the presence or absence of which mean success or failure to the farmer. Nitrogen is an important element in plant and animal tissue. Although it forms four-fifths of the atmosphere, unlike oxygen, it cannot be utilized directly in the gaseous form but must be fixed in combination with elements forming nitrates which are soluble in water and can thus be absorbed by the roots. The chemist has established the fact that nitrates are placed in the soil by

bacterial action, which is in itself a most remarkable series of chemical processes. Not only are bacteria busily engaged in reducing animal and vegetable matter to the condition known as humus but, in the root systems of leguminous plants, are fixing the free nitrogen from the atmosphere in soluble compounds ready for the use of the plants. Nitrogen is also furnished to the soil in the form of commercial fertilizers.

The commercial fertilizer has received a good deal of attention in recent years and here again the chemist has played a leading role. Before the war the chief source of nitrogen was the nitrate deposits in Chile. Potash, also in much demand, was found chiefly in Germany. The war interfered with the movement of nitrates from Chile and potash from Germany. Some years earlier steps had been taken by chemists looking toward the securing of nitrogen from the air. Electricity aided in the solution of the problem. In Norway water power had been found well-adapted for the economical production of electricity. This process of taking nitrogen from the air and fixing it in soluble compounds, perfected by the chemists of Germany, enabled that country to continue the war much longer than she could otherwise have done. The scientific fertilization of German farms has produced greater increases in grain per acre than has similar treatment of fields in any other country. Without the supply of nitrates made possible by the chemist, the people of Germany must have starved.

A similar development looking toward the production of large quantities of nitrogen fertilizers has been undertaken in this country in the construction of the Muscle Shoals Hydro-electric Plant. The uproar regarding the policy that the government should pursue in regard to the Muscle Shoals plant must not cause the farmers to lose sight of the essential fact that through the successful operation of such a plant as that at Muscle Shoals, the science of chemistry brings to agriculture the means of greatly increased prosperity. Supplies of fertilizers produced on the farms are limited. The natural deposits such as those in Germany and South America are also limited and not at all times accessible. The fields of American farms have already reached the condition where the supply of plant food must be renewed. The production of nitrogen compounds by chemical processes and at a reasonable cost is indeed an achievement of much importance. We may rest assured that the chemical profession, will, by continued investigation, make every effort to supply other fertilizer needed by the farmers.

Not only does the nitrogen supply of the soil become depleted, but an excess of acids sometimes accumulates producing what is commonly called a sour soil. The chemist after determining the condition of the soil prescribes the application of lime or other element that will best neutralize the acidity. In many localities, too, the productivity of the soil is greatly reduced by the presence of considerable quantities of alkaline substances.

As there are many kinds of alkalis, each with its own peculiar properties, the treatment of the soil must depend upon the particular alkali present as well as the general nature of the top soil and the sub-soil. How shall the farmer determine the proper means to employ in restoring the productivity of his field? Close observation and years of experience will guide him somewhat, but experience is a long and often costly process. The agricultural chemist is prepared to analyze the whole situation and give the farmer definite information as to the condition of the soil and the best method of treatment.

James J. Hill's slogan was: "Raise more wheat," but at the present time farmers are more concerned about getting more for the wheat they raise. For years the farmer hauled his wheat to the elevator and took what was offered. Realizing the manifest injustice of this one-sided marketing system the farmers tried numerous schemes for handling their own product. It was, however, not until the chemist came to his assistance and determined the real value of his wheat by means of chemical analysis that the farmer began to have an accurate basis for determining the value of his wheat. Millers know that the most satisfactory bread is produced from standard flour, that is, flour the component elements of which are present in definite proportions. Soft wheats lack a sufficient amount of certain necessary elements. Hard wheats have an abundance of the desired substances and are consequently in much demand by millers for the purpose of blending with the soft wheat and producing a standard flour. The work of the chemist has made the establishment of just grades possible. A sample of every carload is now analyzed and the correct value determined. Millions of dollars are thus added to the returns from wheat produced in the hard wheat belt.

The sale of other farm produce is also, to large extent, regulated by chemical analysis. Corn, oats, barley, hay of all kinds are graded upon the feeding value present. The determination of the butterfat content in milk and cream is dependent upon the action of sulfuric acid on certain elements in the milk, changing their nature so that when separated from the butterfat by the centrifugal action of the machine, the percentage of the butterfat can be accurately measured. In this connection it might be well to observe that chemical processes are very closely associated with physical laws. In fact chemistry and physics are simply two man-made divisions of the science of matter and energy. The relation of physical principles to agriculture would form the basis of a most interesting discussion, but being without the scope of this discourse is referred to only as it is inseparably related to chemical processes.

The chemical analysis of feed grains and forage crops, referred to above, as a means of determining the market value of such products is of still greater importance when applied to the feeding of livestock on the farm.

Good business economy directs that the farmer dispose of his products in the form that brings the greatest returns. The distance from market, the bulkiness of grain and hay are factors to be considered. The fundamental consideration in converting such bulky produce into more concentrated forms such as beef, pork, mutton, poultry, eggs or dairy products, is to use the available feeds so as to get the greatest possible value in return. Here again the chemical analysis of feed grains and forage crops provides a basis for intelligent feeding. But the agricultural chemist goes farther. By a long series of carefully conducted experiments he determines the combinations and proportions of feeds that will best achieve the purposes of the stock feeder. Thus scientifically are balanced rations worked out for the work horse, the growing colt, the milch cow, the beef animal, the brood sow, the growing pigs, the laying hens, and the fattening poultry. The farmer's problem is now to work out the comparative market values of the rations so as to make the greatest gain at lowest cost. Because of the instability of market prices, the feeder has an ever-changing problem, but chemistry has given him the foundation upon which to base his calculations.

Another of the farmer's problems has been to control the insect pests and plant diseases. The flies, beetles, bugs, and worms, the scabs, wilts, and rusts that infest fruit trees and field crops are legion. The botanist studied the dieases of plants, the zoölogist learned the nature and the habits of the insect pests, and the chemist worked out the remedies and their application. The fruit trees must be sprayed at the proper time with a spray designed to destroy the pest without injury to the fruit. Infected fields are treated with grasshopper or cutworm bait prepared according to formula. Live stock infected with skin diseases are dipped in solutions containing disinfectants. These disinfectants the chemist has produced from coal tar and petroleum. The beneficial actions of medicines, liniments, salves, fly oils, etc., are largely chemical in their nature.

In the field of farm power, chemistry plays an important part. Until recent years the steam engine was most commonly used for larger operations than could be conveniently performed by horse power. So common, indeed, did the steam engine become that people ceased to marvel at the greatness of its power. To the thoughtful mind, water, the most common of substances, is a compound composed of two gases which under the influence of heat is transformed into a power that turns a dozen furrows with ease, draws a hundred cars of grain at race-horse speed, or drives a mighty vessel through wave and tempest. Steam is a wonderful power and unsurpassed for many purposes. Where lightness, compactness, and convenience are important, the internal-combustion engine has the advantage. Here again chemistry plays its part. Have you ever wondered why the carbureter on your gasoline engine or car required such

careful adjustment in order to develop the greatest power? Ask the chemist. Or why does a particular kind of lubricating oil give better results in a certain type of engine than do other oils? The chemist has worked out the facts relative to the perfect combustion of gases, also the properties of lubricating substances. Has the farmer been troubled with valve stems or springs that were too hard and broke? Have bearings cut out and required re-babbitting? Has the success or failure of farm operations ever depended upon the quality of the iron, or steel, or babbitt, or rubber that went into the construction of the farm machinery? Every manufacturing plant of any size is today equipped with its corps of chemists whose business it is to test and analyze the raw materials and to produce the quality that will best suit the purpose of the finished machine. Chemical inspection has become a part of modern manufacture and enables the manufacturer to stand back of his product with a guarantee that is a real protection to the buyer. Farmers quickly recognize the advantage of using equipment and supplies put on the market by concerns of established reputation.

Farmers are large users of gasoline and other petroleum products and a falling off in the supply of natural oil would be keenly felt. As the demand for gasoline increased, concern was felt lest the shortage cause the price to become prohibitive. Government chemists, however, developed a new process by which a much larger percentage of the petroleum can be reduced to gasoline, and by so doing greatly increased the supply and stabilized the price.

Gasoline and kerosene have become convenient fuels in farm kitchens, especially during the summer months. The combustion of fuels of all kinds with the accompanying liberation of heat is a chemical reaction. The comparative merits of coal and wood, or different kinds of coal, depend entirely upon the chemical ingredients. The formation of new fuels by chemical means has been an interesting field of investigation. The making of fuel alcohol from waste products found on every farm has been found possible and will undoubtedly receive greater attention at some future time.

The chemistry of fuels suggests also the chemistry of foods, and of cooking, a topic of much interest to the farm housewife. Farm women are, in general, classed among the most successful cooks and housekeepers. A working knowledge of the chemistry of foods, of cooking, of the use of cleansing and disinfecting agents adds interest to her work, leisure moments to her days, and improves the general health of the family.

In the repair, preservation, and beautification of farm buildings, paints, varnishes, and stains are extensively used. The linseed oil in paints combines with the oxygen in the air forming a water-proof surface that protects buildings from moisture and decay. The coloring matter in paint is a chemical product. Creosote stain used for shingles, etc., is a coal-tar

product. The rapid drying, the luster, and other desirable qualities of varnish are the result of chemical action.

In this brief discussion it has been possible merely to suggest the close relation that exists between chemistry and agriculture. The world of nature is one great laboratory in which chemical changes are continually taking place. The preparation of plant food, the growth of plants, the action of bacteria are all chemical processes that make agriculture possible. For ages man farmed blindly, hampered by ignorance of the science that lay at the base of his enterprise. For the most part, the life of the farmer has been one of drudgery, incessant toil, privation, and loss. It is not surprising that the tillers of the soil were the serfs, the debtors, and that the ambitious and the destitute alike quitted the land for the possibilities of the city. With the coming of the knowledge of chemistry that makes the farmer the master of his craft, the scene is changed. Futile effort and wasteful practices are eliminated. Crops and livestock are protected against loss. Chemistry establishes the value of the farmer's product. Power lifts the load from tired shoulders, multiplies the farmer's accomplishments, and gives him time for the enrichment of life. Rapid transportation and communication have emancipated the farm people as social beings. Best of all, the mental attitude has changed, both of the farmer toward his occupation and of people, in general, toward agriculture. The farmer's knowledge of chemistry and of the part that it performs in agriculture gives to him confidence, enterprise, a sense of power, satisfaction, and contentment that were impossible before. Toward the devoted scientists whose labors have made this marvelous change in agriculture possible the farmer can have only a feeling of confidence and esteem.

HAROLD WALKER

Friends of Harold Walker, instructor in chemistry at the Rapid City, S. D., high school were shocked to learn of his sudden demise on May 7th. It was known that he was ill of scarlet fever but his condition had not been considered serious until shortly before he passed away.

Harold Walker was born in Daleville, Ind., December 25, 1897. He was valedictorian of his high-school class at Middletown, Ind., and graduated with distinction from Indiana University in 1920. In 1925 he received his master's degree from the University of Chicago.

Walker was a member of the Senate of Chemical Education and delivered a paper at the recent Tulsa Meeting of the American Chemical Society. He is survived by his parents, Mr. and Mrs. Charles Walker and his sister, Mrs. Young, of Daleville, Ind.

THE RELATION OF CHEMISTRY TO THE HOME

J. MAPLE WILSON, JR., MISSOURI SCHOOL OF MINES, ROLLA, MISSOURI

Of all those seemingly vague and strange things that are related to our home and home life, perhaps none is more important or more closely related than chemistry, that science on which the most of us are wont to cast a rather suspicious, or even fearful look, and then shy off as if it were a thing to be feared and left only to the chemists; those men who choose to spend their lives in their laboratories, those smelly workshops where so many mysterious things happen. But let us be more friendly with these men and their work and see some of the things they have accomplished and how they have made living easier and more pleasant for us.

J. MAPLE WILSON

To begin with, what is this thing that a few men have puzzled their heads over so much and call chemistry? Perhaps you say it is only a sort of a guessing contest, where chemists blindly mix some substances together, help them along by heating or some other such treatment, and then wonder what will come of it all. But such ideas are mistaken; chemistry is a science and science has been defined as "organized study." This means that we must have something definite to study, and Berthelot, one of our greatest chemists, has given us the first comprehensive definition of chemistry. He has called it "the science of analysis and synthesis." These two terms must go together, for analysis is the science of taking apart while synthesis is the science of putting together. Without analysis we could not have synthesis and without synthesis we could use but little of the knowledge gained from analysis.

It being understood then, that chemistry is a science and that the business of the chemist is to analyze and try to synthesize, let us see where and how this business is related to the home. What are some of the things he has made for us; how did he find out what they are made of, and having learned that, how did he put these things together to make what he wanted finally?

Beginning with food, the most essential thing to life, a little reading will show us that the chemist's part has been no small one in the development of food as it is made, flavored, and seasoned for us today. Time was, thousands of years ago, when the man who felt hunger would patiently lie

waiting at some well-known water hole until his meal showed up, when he would use what means he knew to make his kill, and would then devour raw what part he wanted, torn from an undressed carcass with hands that seldom felt water, never felt soap, and did not know anything of sterilizing methods. Then one day he somehow happened accidentally to drop some of his meat in the fire or on a hot stone and when he recovered it, found the flavor of cooked meat very agreeable. Since then we have advanced, slowly at first, more swiftly recently, until we have our present-day methods of handling food, and we have even learned to make a substitute for the meat we eat so much of. The food chemists got busy on this proposition of flesh and found that it was made up mostly of nitrogen, one of the most abundant elements we have, in the form of protein. Someone else later found out that the cottonseed husk, which is about 800 pounds of every ton of cottonseed, and had always been discarded, could be treated and used for cattle feed, and the accommodating cows would make steak of it for us. Not to be outdone, another man took the "oil cake," or what is left of the kernel after the oil is pressed out, and began to work with it. The latest report is that a very palatable and no less nutritious hamburger has been made from this waste product of the oil press! Who dares to say what these chemists may some day do for our food?. Having learned what foods are made of, is it not quite possible that they may some day concentrate a day's nourishment in a small pellet, which we can swallow in the morning, after which the bother of cooking, eating, and dishwashing can be forgotten?

Another of our most important foods than meat has been made much more palatable, as well as more plentiful, by the work of the chemists. The ancient Greeks had among their collection of true and untrue tales one from India that there grew there strange trees that bore wool and reeds that made honey. Later they found this to be true and began to get bits of crude cotton cloth, and a sort of edible sweet that was called "sukkar" by those they got it from. The invasion of Spain by the Arabs spread its use into Europe and so the sugar industry began to grow. As the demand for sugar grew, the chemists began to search for some other source. Finally in 1747 a German named Marggraf, found that he could get a little sugar from beets. Since then the sugar beet has been cultivated and methods of extracting and refining it have been worked on until today beet sugar is quite as commonly used as cane sugar. The first sugar extracted from the beet root was dirty and bitter, and it has taken much work and experimenting by the chemists to produce our pure, white, sweet beet sugar of today.

Since man in some way discovered that the addition of certain oils or extracts to his food would greatly improve the flavor of some things, we have been constantly trying to make new flavors, and synthesize those that

nature provided for us. Chemists have learned that a certain arrangement of atoms in a substance give it the properties peculiar to it, such as a certain color or odor or taste. Thus he has found that the fruity odors are almost all compounds of the type known to him as esters; that is, the result of the union of an alcohol and an organic acid. If we want to make some of the extract that gives the pineapple its very agreeable odor and flavor we take a little butyric acid, the same as gives rancid butter its unpleasant odor, and mix it with some ethyl alcohol, like that occurring in the alcoholic drinks of pre-Volstead days, and the result is synthetic pineapple; not a substitute, but the same as that occurring in the fruit. In the same way, pear oil is made from amyl alcohol, or fusel oil, and acetic acid, which is the acid occurring in vinegar. These fruity flavors are all compounds in which the carbon atoms are hooked up in a row, as in a chain, and if we take a ring compound, or one in which the ends of the carbon chain are fastened together to form a circle, we find a different sort of flavor. Suppose we go into the grocery store and call for a bottle of vanilla flavoring. The common idea is that this flavor is the extract from the vanilla bean, but most likely it is the product of a laboratory, another result of the chemist's study and experiment. Most likely the manufacturer started with phenol, better known to us as carbolic acid, which had been made from coal tar, and treated it with a strong alkali and some chloroform. The result was an odorless white powder and an oily liquid. This liquid was then treated with acetic acid and the result was cumarin, which has the odor and flavor of vanilla, and is the same as the extract from tonka beans, which is used in vanilla flavoring. Or if we call for oil of wintergreen, it is not the oil extracted from wintergreen berries that we get, but another child of the laboratory, and incidentally, another offspring of the poisonous carbolic acid. In this case the phenol was treated with carbonic acid, or soda water, and the result was salicylic acid, which is known as "fruit acid" and used in preserving, and in medicine as a rheumatism remedy. This salicylic acid was treated with poisonous wood alcohol, and the two combined with the aid of a little sulfuric acid, to give the synthetic, but true, oil of wintergreen.

Next in importance to food in our lives comes clothing. The chemists' part in the manufacture of cloth and clothing has been more recent, but no less important than his part in the manufacture of foods and food products.

In 1844 John Mercer, an Englishman, found that dipping cotton cloth in a strong solution of cold alkali and then drying it, shortened and strengthened the fiber. He thought very little of it, but several years after, some one discovered that if the fibers were held stretched out so they could not shorten while drying, they became smooth and shiny like silk, and today we have "mercerized" cotton that passes for silk.

Some time later, another Englishman named Cross found that if this

mercerized cloth were dissolved in carbon disulfide, which is the evil-smelling "high life," and then the caustic in it neutralized by a little acid, the cellulose, or cloth substance, could be recovered, but in a slightly different form. By squirting this solution of cellulose through tiny holes into water containing acid, silky threads were formed that could be spun and woven. The artificial silk threads look quite as well as the natural silk but they are not quite so strong and do not wear as well.

No small part of the manufacture of cloth and clothing is the dye industry and it is in this phase that the chemist's art has played its most important part. Almost all the dyes in use today are organic dyes, so-called because it was originally thought that only living organisms had the power to make the organic compounds. Today we not only know that man can make nearly any of nature's substances, but can make many not occurring in nature at all. Such are many of the dyes we use so extensively, and it is much to our advantage to make our own colors rather than to try to find them in nature, for the chemist has taken these dyes apart and knows what they must contain and how the constituents must be arranged to give certain colors or shades. Then if a certain color is wanted for a bit of cloth, or even for foodstuffs, he knows how to go about making it.

It is to William Henry Perkin, an Englishman, that we owe the beginning of the coal-tar dye industry. When he was only 17 years old he started research work on the problem of preparing artificial quinine. He had started with coal tar and had distilled from it the benzene from which he made aniline. He was working with this aniline and in attempting to get from it phenanthrene from which to make his quinine, he got instead a black, dirty, tarry mass. In attempting to wash this out with alcohol he was surprized to get a beautiful purple solution. When he attempted the same thing with some pure aniline, he found that he could not get the same results. This led to the discovery that the aniline in the first case had contained a little toluidine, and thus "mauve," the first of the coal tar dyes, was discovered. Perkin continued his work with coal tar colors and ten years later made the dye known as "Turkey Red." Another of the important discoveries in the beginning of dye manufacture was the method for making Tyrian purple, which, because of its prohibitive price had been the distinguishing mark of royalty. Far outshadowing this discovery was the discovery of the method by which indigo could be made on a commercial basis. Indigo was one of the oldest and fastest of the dyestuffs and consequently one of the most used. Chemists had known for some time that aniline could be gotten from indigo, but how to get indigo from aniline was their problem, and it required several years of work and much money to learn to make it. Now, however, we have indigo of definite known quality and strength in abundance, made from the formerly discarded coal tar.

By such work and study the manufacture of colors from coal-tar derivatives has advanced until we know now over nine hundred distinct colors, bearing more than five thousand different names. Up to the time of the war, the coal-tar dye industry was practically controlled by Germany, but in the last few years much work along this line has been done by our own countrymen, and we have a very good chance of becoming independent of other countries in the matter of dyestuffs in a few years.

Now that we have at least a brief insight into the chemist's work in connection with our food and clothes, let us go to the matter of fuel, another of the vital things to our homes, and see wherein chemistry is related to our fuel supply.

Considering coal and wood as they are obtained and used for fuel alone, there is no chemistry connected with them, but if a wider use of coal is considered it becomes quite different. The gas that is commonly used in city homes for cooking and sometimes for lighting or even for heating is made from coal. If we take a little soft coal and heat it in a test tube we will get a heavy brown smoke given off that burns readily if a flame is applied to it. Such a process of heating the coal without contact with a flame is called destructive distillation, and many things are driven off from the coal. In this heavy smoke is contained the coal gas, along with certain impurities that must be removed to give us clean gas. It naturally became the chemist's job to clean the gas, and so he had to go to work to find out what was in there and how to get it out. If the gas were burned as it comes from the coal, it would give a smoky, yellow, cold flame and create disagreeable odors. So by cooling the gas, washing it with water, and passing it through towers containing small scraps of iron, the poisonous hydrogen sulfide, the benzene, naphthalene, and coal tar were removed, as well as any other impurities so that the gas as consumed is fairly pure, and gives an odorless, hot flame. Water gas, which is often used, but is not nearly so common as coal gas, is made by passing steam over red-hot coke.

Those who have their own gas plants such as the farm-home plants, use quite a different kind of gas from either of these. It has been named acetylene, and since it is made up of two particles each of the elements carbon and hydrogen, the chemists abbreviate its name to the symobl C_2H_2. It is made from what we commonly know as "carbide," really calcium carbide, which is a product of the electric furnace. Calcium carbide is made from quicklime, which is the oxide of the metal calcium, by heating it in an electric furnace to extremely high temperatures with coke. When water is poured on carbide, a reaction takes place which results in the formation of acetylene gas and slaked lime, and the gas plants using carbide are made to give this reaction, with a tank for storing the gas and furnishing the pressure necessary to force it through the pipes. Acetylene gives the hottest flame of any gas when burned with pure oxygen, and it is

an oxy-acetylene flame that we see machinists using to cut and weld heavy pieces of iron and steel.

Another fuel more commonly used than gas is oil, in the form of kerosene or, less commonly, gasoline. The process of making kerosene from crude oil is a process requiring the aid and supervision of the chemist almost from the crude oil to the finished product. As the oil is taken from the well it is a black, dirty looking liquid, considerably heavier than kerosene, and though it will burn in this form, it would be rather unsatisfactory as well as extremely wasteful to use crude oil for fuel. The lighter kerosene and gasoline must be separated from the heavier oils and to do this, the crude oil is distilled or boiled at different temperatures, beginning at the boiling point of the lightest gasoline and getting higher as the lighter oils boil off. As the vapors come off they are run through a cooler and condensed, after which they are treated to remove any impurities, corrosive substances, or other undesirable things. The oil is then ready to be used, but the quantity thus obtained represents a relatively small part of the crude that was started through the stills. Chemists have studied all the oils and have found that all the different grades, or fractions, are very similar, some of the heavier oils being the same as the lighter except that several particles of the light oil have combined to give one particle of the heavy. It is plain then that if the combined particles could be broken up the product would be the lighter kerosene and gasoline. Such processes are known as "cracking" the oils, and rather satisfactory methods for cracking have been worked out, the best being the Dubbs process and the Cross process, named for their inventors. In both these methods the oil to be cracked is heated in a large retort built almost the same as a tubular steam boiler, at temperatures of about 1300 degrees Fahrenheit, and under high pressures. The result is a grade of gasoline and kerosene hardly equal to the first product from the crudes, but fairly satisfactory, and a boon indeed when we think how rapidly our supply of crude oil is being depleted.

Under this discussion of fuel and sources of light it is quite appropriate to give a word to the development of the electric-light filament. Those who have used electric lights for more than ten years are doubtless acquainted with the old carbon filament light bulb and its comparatively dim light. These little threads of carbon were made much the same as artificial silk; that is, by making a solution of the cellulose and then squirting it through small holes into a solution that would restore it to its original form. These threads of cellulose were then charred and used as threads of carbon. But this carbon filament was very inefficient and wasteful and some other material was sought after that would give more light for the amount of current consumed. It was found that the rare metal tungsten was such a material, but it was so hard and melted at such high temperatures that it was impossible to get it into the shape in which it could be used. In 1912

the first satisfactory method was devised by Dr. W. D. Coolidge, who made the powdered metal by reducing one of its compounds. This powder was then molded into bars under pressure and the bars heated to white heat in an electric furnace. While hot they were rolled down into wires and these wires were drawn through small diamond dies. This filament of tungsten gives about three times as much light for the same amount of current consumed as the old carbon filament.

The advancement of medical science to the point it has reached today has been highly dependent on the work of the chemists in this field. In the homes of a hundred years ago very few remedies were known, and the power of most of these lay in their psychological effect. But since the work of the organisms we call germs on the body has been studied, and the effects of the poisons they create is known, the chemists can isolate these poisons and find something to combat their effects and at the same time aid the body in fighting the germs and repairing the destruction brought about by them. Thus chemistry has created for us the many antiseptics that we use so often. If we cut a finger or scratch the skin, we apply a little peroxide, some iodine, or some one of the many aids that have been given to us by science.

But it is not only in the field of antiseptics that chemistry has worked wonders for our health. In those cases where some vital gland ceases to secrete its certain essential fluid, or some organ fails to function, there can sometimes be supplied from an artificial source the substance that is lacking. About the best illustration and most remarkable development along this line has been the isolation and use of the substance known as insulin, used in the effective treatment of diabetes. When persons are affected with diabetes the liver is at fault, failing to hold the food sugar and convert it into a form in which it can be used by the body. If the person affected is given a dose of insulin it seems to give the liver the power temporarily of functioning as it should, and while its effect on adults is not permanent, and dosage must be continued, the insulin has in some cases effected permanent cures in children. The chemist's part in this work has been in finding a method for isolating the insulin, which is obtained from the pancreas of sheep. A method has been worked out successfully for this, and a good bit of work has been done on the analysis of insulin, but it is rather intricate work and has progressed slowly. However, it is certainly quite possible that some day this work will be completed, and a method for synthesizing may be worked out.

This is only one of the marvels in medicine that has been dependent on chemistry for its development, and there are many others. The manufacture of all our medicines and drugs is dependent on the chemist in some or all of the processes involved, and it is to the ardent work of the chemists that we owe the ability to synthesize a good many of the sub-

stances used in medicine, thus making them of constant and known strength and purity, as well as more plentiful and cheaper.

Among those things used almost as much, but really less necessary than food and clothing, fuel and medicine, are those hundreds of articles found all over the home made of celluloid, bakelite, redmanol, and other similar substances known to chemistry as the plastics and condensation products. Celluloid, pyralin, and the many kindred products under various names are known as synthetic plastics, while bakelite, redmanol, condensite, and the synthetic resins are known as condensation products.

The discovery of celluloid, or rather of a way of making it, began with an accidental discovery by a New Yorker, John Wesley Hyatt. His profession was typesetting, but he was trying in his spare time to find a satisfactory substitute for ivory for the manufacture of billiard balls. The typesetters used the preparation that is commonly used now, called collodion, for protecting cuts or sore places on their fingers. This collodion was made by treating cotton with nitric acid to make nitro-cellulose, or guncotton, which was then dissolved in alcohol and ether. One day when Hyatt went to get some collodion to protect a sore place on a finger, he found the bottle overturned and the collodion spilled out on the shelf, dried and hardened. Seizing on this idea he attempted to cover balls of other material with the collodion, but they were unsatisfactory, and it was 40 years later that he finally solved the problem. He found that by combining the nitrocellulose with camphor with the aid of heat and pressure, he had a substance that was exactly what he wanted. He named this substance "celluloid" and the process of manufacture today is still almost the same as started by Hyatt in 1870. Celluloid can be made transparent, white, or any desired color, or made to resemble natural ivory by welding together lighter and darker sheets, with occasional irregularities, to resemble the graining of ivory.

When warm, celluloid can be cut and molded into any desired shape, and by reason of this and its many other desirable and specific properties, it is used for uncounted purposes. A few of these include the making of combs, brushes, mirrors, knife handles, cane and umbrella handles, pins, badges, hairpins, piano keys, toys, penholders, card cases, and an almost unending list.

Chief of the disadvantages of celluloid is its inflammability. Experience has taught us all that it takes only the touch of a match to ignite any celluloid article, when it will burn quite fiercely. So the discovery of the usefulness of the condensation products was exceedingly welcome. They are non-inflammable and are impervious to water or acids. The discovery of the usability of these synthetic resins was made by a Belgian chemist, Dr. L. H. Baekeland, who was working in America. Chemists had accosted these resins before, but finding them insoluble, non-crystallizing, and impossible to melt, were unable to analyze them and so did not investigate

them. But Baekeland found that the union of phenol, or carbolic acid, with formaldehyde, which we know as a fumigating agent, gave a plastic, resinous substance that was soluble in alcohol. But if heated it became hard, tough, and insoluble. Thus he gave us the "bakelite" that is so commonly used for radio panels, insulating plates, tubes, and other articles.

Redmanol, a similar substance, is made using formin instead of formaldehyde, and on melting this with phenol it gives a clear, amber-colored, transparent substance that is plastic and can be bent and worked into shape. On further heating it becomes hard and insoluble and similar to bakelite except for its color and transparency. Redmanol, by virtue of its resemblance to real amber and its many desirable properties of insolubility, non-inflammability, the ability to mold easily before hardening, and its imperviousness to corrosive substances, is used for making hundreds of useful and ornamental objects, some of the most familiar being pipe stems, cigar and cigarette holders, and knife handles.

The list and story of the hundreds and hundreds of ways in which chemistry is related to our present home life, and has made it possible for us to live as we do today with our countless comforts and luxuries, could be continued almost without end, but space prohibits what, to me, is the continuation of one of the most interesting stories ever written. It must end here with a list of a few of the industries that somewhere in their makeup have chemistry as a vital element, a vigilant watchman whose work is essential to the process, or is even the whole process. A few such industries are: the manufacture of foodstuffs not mentioned heretofore, as cornstarch, salad oils, shortening fats, and corn sirups, all of which are vegetable products; the manufacture of synthetic perfumes to rival those in nature; manufacture of steel and other metals to be used all over the home in every form from nails and radiators to piano wire and talking machine needles; the manufacture of paints and varnishes; artificial leathers; phonograph records; photographic plates, films, and developing solutions, including motion picture film; substitutes for rubber; paper manufacture; ink making; and so on through a list that would include almost every article we could lay hands on, in some relation or other.

It has been the aim of this writing to show as well as possible in a short story how much chemistry and its marvels has done for our home life and comfort, and how closely the two are related. With this in mind, as little as possible of technical terms, formulas, and symbols have been used, in order that it will be more interesting and easily understood by those for whom it is written and to whom it is directed, our "home-folks."

In closing, it is with a sincere hope that this purpose has been accomplished, and with the wish that in any who read this will be aroused an interest in chemistry and a desire to further this wonderful science in whatever way presents itself, be it much or little.

THE RELATION OF CHEMISTRY TO NATIONAL DEFENSE*

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National Preparedness

National preparedness is the only sure guarantee of peace and order in the present state of world relations. Whether or no there will come a time in the future when all problems arising out of the jealousy or friction of states will be adjusted through the arbitration of a World Court, as yet it is only too true that there have been, and still are, "outlaw" nations which openly or secretly prepare for aggressive war. It is evident that, until some thoroughly practical guarantee of peace has been established, "no wise nation will trust to anything but its own strength and no wise people depend... absolutely...on treaties or international arrangements"[1] of a peace council that are liable to be thrust aside.

GEORGE M. HOCKING

Chemistry: Its Use in National Defense

The trend in methods of warfare and, hence, of defense is to the purely scientific engagement of physical and chemical forces. In the very immense and complex system of modern battle, the application of physical science to war needs has become of very vital importance.

The manifold contributions of chemistry to national defense may be divided roughly into two great sections: first, the basic, diverse task of sustenance with no direct connection to active conflict; second, the highly specialized, very essential duties involved in military offense and defense. These two departments are interrelated and one is as indispensable as the other.

Applications at Home

At home, the chemist, as consultant or director of industrial and other pursuits, carries on in war as in peace, his duties being as important in one as in the other. It is important that, when a nation is at war, its people should be kept as contented and orderly as possible. To achieve this end, the population must remain supplied at reasonable cost with a sufficiency of food, clothing, and shelter, and be furnished enough employment for all to maintain an adequate income.

* Prize-winning college essay, 1925–26.

[1] Major Stewart Murray.

First and most important of the duties of the home chemist is that of looking after food production and consumption. It is very important that the soil be fed with the essential element or elements in which it is lacking by means of carefully selected fertilizers. During a shortage of the natural deposit as the result of blockade or because it is needed for other and more immediate purposes, the chemist is faced with the task of preparing artificial fertilizers. By recommending and furnishing requisite plant food, the chemist achieves that important factor in all wartime policy, *viz.*, the promotion of food production by intensive agriculture.

Chemists aid the food administration also in details of regulation and conservation: they carry out such important matters as analysis of suspected adulterants, ascertainment of well-balanced and economical diets, and improvements in the methods of food manufacture or preservation.

War necessity may bring about a dearth of an essential substance and demand the production of an artificial imitation. Substitutes for natural foods, textile fibers, etc., are usually discovered in chemical laboratories.

The industries of a country must be sustained at all times, during both peace and war, and, for successful operation, many demand trained chemical engineers.

Applications at the Front

Every department of war activity is indebted to chemical knowledge and research for the preparation and use of its equipment and for improvements in the same. This dependency is very widespread and interlaced, and only a few of the more apparent cases can be outlined here.

Aviation owes its extensive use and development in large measure to chemical investigation. The metallic materials of air vehicles, for both structural and motor purposes, must be selected with a view to maximum strength, lightness, and durability. Fabrics, lacquers, adhesives, and other necessities of construction are perfected chemical substances. Again, lubricants and fuels are subjects of chemical inquiry. The technical furnishings and management of lighter-than-air machines are, in part at least, under the superintendence of chemical experts. America's recent contribution in this field is noteworthy. The use of inert helium in dirigibles to replace the highly explosive hydrogen heretofore used is a great step towards making these huge machines entirely safe. It is cheering to note in regard to the recent tragedy of the "Shenandoah" that the large proportion of lives saved was due to the use of helium, and that most probably all the crew would have been lost if the airship had contained hydrogen.

Range-finders, glasses, telescopes, and cameras are essential war-aids in such important operations as aiming guns and observing the enemy. The need for production of a high-grade optical glass by the chemist is another demonstration of his significance.

Ammunition, artillery, and firearms form the most important part of military equipment. In the manufacture of these munitions and in all research carried on in connection with them, chemistry is an essential aid. The high-grade steel of projectors, which must stand the strain of great explosive forces and an almost red heat, is a substance requiring careful chemical control in its production. The numerous ferro-alloys invented and used within the last fifteen years give evidence of the number and complication of conditions requiring their use. For the projection and fragmentation of artillery shells, two classes of quick-burning substances are employed. To drive the missile from the gun, a propellant or relatively slow-acting agent, such as gunpowder, is fired; if the almost instantaneous disruption of a high explosive were used, the gun-tube would be shattered. When the projectile has reached its destination, its metallic walls or shrapnel pieces, as the case may be, are broken up and dispersed by means of a high explosive set off with a time fuse or by impact. Primers, detonators, boosters, and other fillings used to touch off the main explosive charged add to the complexity of the reaction and to the chemical details.

Chemical Warfare

Not only is the value of applied chemistry in the whole field of national defense realized by well-informed people today: the important role played by chemical warfare is being more fully appreciated year by year.

Chemical, or poison gas, warfare is a very recent addition to military science, whose future possibilities are probably as revolutionary as were those of gunpowder after its introduction in the fourteenth century. Forced upon Allied attention in the Great War by the aggression of a desperate foe, the efforts made in defense and later in retaliation have resulted in the rapid development of this kind of warfare.

Both sides in the last war employed cloud gas in the first attacks. The gas, discharged from a battery of cylinders, was left to drift with the wind to the enemy lines: this method of handling proved unsatisfactory as success depended on wind strength and direction, and preparation for an attack involved great exertions and dangers. To offset these objections, special projectors were devised and many field-guns used to fire gas shells. This introduced another and even greater modification into chemical methods, *viz.*, the use of liquids and solids which by the explosion of the projectile could be pulverized or vaporized into toxic "gases." A great variety of substances, before known only in the laboratory, was manufactured in large quantities and distributed during the period of brisk chemical competition of 1916–1918.

Some of the combat gases, the asphyxiants, affected the respiratory system; others, the vesicants, blistered the skin; lachrymators or tear gases irritated the delicate eye-membranes causing temporary blindness;

sternutatory or sneeze gases attacked the nasal passages. Individual protection from gas was afforded by the use of special masks or respirators which were fitted over the head or face at the first sign of gas shell or cloud. These helmets were so designed that the poisoned air was inhaled through substances which filtered, absorbed, or reacted with the undesirable component. Efforts at collective protection were usually a failure, although it is likely that there will be great progress along this line in the future.

Gas served two great purposes during the War: first, of course, to kill or disable men; second, to effect "neutralization" of troops by compelling the enemy to wear gas masks continuously, thus reducing physical vigor and morale. Efficiency in transport or operations was hampered by bombarding important or busy positions with gas shell. Before an attack, so-called "non-persistent" materials were sent over in the barrage. These would evaporate or decompose a few minutes after being discharged so that the enemy would be dehabilitated while the advancing troops would not be affected by their own gas. On the other hand, "persistent" gases, which remain unchanged for weeks, were used for harassing the hostile army or keeping it at bay in a retreat.

An ideal war gas should be colorless, odorless, and tasteless, in order to give the enemy no warning of its presence; it should be subtly, not noticeably or suddenly, poisonous; of greater density than air; and slow to react with everything except animal tissue. Since a toxic gas has to be produced in large quantities, sufficient of the raw material must be on hand, and manufacture must be rapid. If the agent is a true gas or vapor, it must be compressible or liquefiable in order to occupy minimum shell space. All stages in the preparation of war chemicals were developed and supervised by chemists; all analysis of the enemy's chemical compounds and all research relating to the discovery and application of gases was assigned to trained chemists.

The national defense is beneficial only when it embraces up-to-the-minute methods and equipment and when it is dependent on war material manufactured within the country from its own natural resources. Defense is only too often the source of a continual drain upon the public money; therefore, any measure that would reduce or regulate the heavy financial expenditure required for the upkeep of adequate protection would be profitable to the whole nation. The nation which avails itself of home-produced war materials is practicing economy, since money is kept from leaving the homeland to enrich other quarters, and domestic labor is employed.

Chemical warfare, from the standpoint of being modern and economical, is an almost perfect instrument of defense. It is yet more economical and advantageous when the country has its own firmly founded and government-protected organic chemical industry—the source of all toxic gases

with a few exceptions. In the future, it will not be safe for any power to be without this highly essential industry, no matter how strongly armed in other ways—for one side with such a potential armament could easily and quickly conquer another without this advantage.

Gas warfare is sometimes considered by unenlightened or reactionary people as being the most hideous and cruel form of strife yet devised. In as much as all war has but one object—that of conquest by putting soldiers out of action—gas warfare is a legitimate means of offense. It is even less painful probably to be killed suddenly by fumes than to die in agonies through the bloody effect of "shot and shell" or bayonet. Records from the European War show that about 28% of the total casualties of the American Army were due to gas; of these, only 2% died, whereas at least 27% of all other casualties were killed. This means that an invalid from gas had fourteen times as much chance of living as one hurt otherwise. If the patient was alive after forty-eight hours, all danger was past, and no permanent after-effects whatsoever were left as in the case of most other war injuries.

The emphasis laid on chemical warfare by the major nations since the World War makes plain its vital position as a bulwark to the nation's safety. In England, the Chemical Service has assumed as important a place as the Army, Navy, and Air Services. France, Japan, Russia, Italy, and other powers are putting more and more trust in purely chemical methods of defense.

Chemical warfare is the "most feared, humane, efficient, and financially economical military weapon,"[2] and the development of a strong organic chemical industry provides an almost ideal warrant of national security.

Organic Chemistry and National Defense

Since 1856—the year of the discovery of the first coal-tar dye, aniline mauve—the manufacture and use of complex organic chemicals has increased, until now a large number of industries are dependent, in whole or in part, upon the dyestuffs industry for substances made by it alone. It is neither a very large nor a particularly lucrative business, but it is a key industry, and in this lies its immense importance.

In the United States, over $3,000,000,000 worth of business must be kept supplied by dye manufactories with necessary colors or related chemicals. A few of the most important trades thus concerned are those having to do with textiles, paper, printing, leather, and paint. Because all trade must be supported during war time, the value of a home organic chemical industry should be obvious. This country suffered at the beginning of the war, when Germany, from whom she had been regularly purchasing her stuffs, cut off the supply of dyes.

[2] H. E. Howe, "Chemistry in World Affairs, Part III," *Sci. Am.*, **133**, 175 (1925).

Medicines and drugs are, in the majority of cases, derived from coal-tar distillates, and usually by processes almost identical with those pursued in the manufacture of dyes. They are similar in chemical structure and properties to dyes and dye intermediates; by a little further treatment, these latter may often be converted into medicinals. In fact, many companies manufacture pharmaceuticals and dyes both, so that any otherwise useless by-product might be transformed into a valuable commodity. America should take warning from her painful punishment of 1916, when, due to her lack of an organic chemical industry, and, therefore, of drugs, "Bulgarian" operations had to be performed without the soothing aid of sense-dulling novocaine, and millions suffered through the absence of many alleviating substances.

Explosives and "poison gases are the products of the materials, apparatus, processes, and technic found in dyeworks and nowhere else. It is equally true that the protective defenses against gas attacks, such as the chemicals found in gas masks, have been discovered and developed in dyeworks. Hence, dyeworks in times of peace are potential munition plants maintained and equipped to become, in the event of war, actual munition plants on almost a day's notice."[3] In the late war, the Germans had a great advantage in possessing what really constituted a world-wide monopoly of chemical warfare materials: explosives, gases, and numerous commercial necessities. When Germany saw her advantage, she embarked on an intensive chemical campaign to attain her ambition of holding rank as military and commercial master of the world. The Allies, not being in a position to produce as much or as effective a variety of gases as they could had they had the same chemical organization as the other side, were held back in spite of their numbers. Success came only after, and was in large part due to, the efficient chemical system developed by the Allied armies.

During the Armament Conference held at Washington in 1921, a report was made by a special committee of specialists on "Poison Gas." In it appeared the following forcible statements:

"Owing to the enormous use of potential warfare gases in peace, it is impossible to take effective steps to prohibit the production of these gases. . . . .It would only be possible to restrict production of such gases by a universal regulation of chemical industry and commerce, giving to each and all nations the means to provide for its own needs but no more.

"Chemical warfare gases which are not used in peace time have a chemical constitution akin to that of materials in commercial use. The result is that it would be possible during a period of strained relations to prevent a potential enemy, should he so desire, in spite of agreements and the threat of very severe penalties under international law, from manufactur-

[3] *Opinion of the Court*, U. S. Circuit Court of Appeals, U. S. A. *vs.* The Chemical Foundation, Inc., p. 20.

ing gas on a large scale only if limitations of the nature of those mentioned in the preceding paragraph were placed on peace industries, such as the dye industry.

"Even if only one Power in the world refused to keep an international agreement to abstain from using poisonous gases, on its declaration of war the general agreement would automatically be nullified.

"The probable result of the employment of gas by an unscrupulous enemy, contrary to agreement and in the absence of a sufficiently severe penalty under international law, would be so serious that *no country dare accept the risk of being found unprepared to meet it.*"[4]

The Hartley commission, appointed by the Allied governments soon after the Armistice to investigate German chemical works and their relation to the War, made an illuminating report, whose central theme may be summed up in a paragraph extracted from it:

"In the future, it is clear that every chemical factory must be regarded as a potential arsenal, and other nations cannot, therefore, submit to the domination of certain sections of chemical industry, which Germany exercised before the War. For military security, it is essential that each country should have its chemical industry firmly established."[5]

Other Chemical Industries and National Defense

Cellulose, available usually in the form of cotton, hemp, flax, and wood, is important at all times. From it are made paper, guncotton or nitrocellulose, collodion, artificial silk, and celluloid. This country possesses an ample supply of natural cellulose at present, but in the near future it will be valuable, and, possibly, at a more remote date, absolutely necessary, to have an artificial source of supply. We should not be behind in carrying out investigations on the synthesis and nature of cellulose, and also on the preparation and use of its many forms and compounds. The great waste which abounds in the industries concerned with the lumbering and distillation of wood should be rectified.

We cannot do without nitrates in agriculture, industry, or warfare. The deposits of Chili saltpeter, with which the world has been kept supplied for many years, will not last forever. Another war might cut us off from this accumulation of fixed nitrogen. It is our duty, then, to take pattern from Germany who, before entering the Great War, had organized an artificial nitrate industry, combining air nitrogen into usable compounds by the Haber process. Muscle Shoals, Alabama, is a potential nitrate manufactory. Although at present unoccupied, it remains a protective establishment, since at short warning it could be turned into a vast producing plant.

[4] *Ind. Eng. Chem.*, **17**, 662 (1925). Extract from Report of Sub-Committee on Poison Gas, Washington Conference, December 8, 1921.

[5] *Ibid.*, **17**, 575 (1925).

Conclusions

Interest in chemical science, pure and applied, has shown a marked acceleration in the United States within the last few years, due in large part to the competitive influence of the Great War. It is hoped that this growth of spirit, with its attendant material progress, will not cease.

To achieve national solidarity, the chemical industries which are indispensable in wartime must be strengthened: to depend on neighboring countries, in case of war—as in the past—would be fatal in the future. Much has been done already in promoting these, our greatest assets of defense, but many problems lie before and enemies to American enterprise are thick.

All chemical industry should be stimulated and sustained by government and financial interests, for chemical resources and development are the bases of political and economic strength and stability. That nation will benefit most in future competition, whether commercial or military, which possesses the most widely distributed and massively built chemical industry. This mighty republic, so chemically weak in the past, should endeavor by every means possible to guarantee and absolutely free home industry, lest one day she be "weighed in the balances,. . . and found wanting."

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Gold Changed to Mercury by German Physicist. A reversal of the dream of the ancient alchemists, the transmutation of gold into a less valuable metal, mercury, is claimed by Dr. A. Gaschler, an associate of Prof. A. Miethe, who in 1924 announced that he had succeeded in turning mercury into gold.

Dr. Gaschler's process consisted in sealing a gold electrode into a vacuum tube and bombarding it with a stream of positive hydrogen atoms, shot through the tube at high velocity. The resulting color display Dr. Gaschler watched through a spectroscope. At first the only light given off was of the color characteristic of glowing hydrogen, but at the end of thirty hours of bombardment the spectrum lines that indicate the presence of mercury appeared and became stronger as time elapsed.

The experimenter states that an oil pump was used to produce the vacuum, and that every other precaution was taken to prevent the contamination of either the gold electrode or the hydrogen gas with mercury. He is confident that he has actually produced mercury from gold.

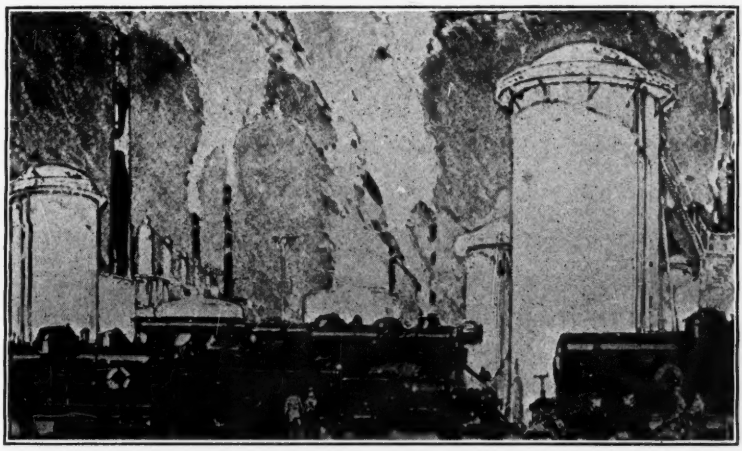
Dr. Gaschler calls attention to the similarity of his work to that of a British Physicist, J. J. Manley, who succeeded in inducing helium to form a chemical union with mercury by bombarding mercury with a stream of helium atoms. Helium had long been known as one of the most inert of the elements, never forming compounds with any of the others.

He is of the opinion that if his results are confirmed upon further repetitions and refinements, they will lend support to Dr. Miethe and Dr. Hantaro Nagaoka, whose claims that they changed mercury into gold have been subjected lately to skeptical criticism.—*Science Service*

UNPUBLISHED DIRECTIONS FOR "ORGANIC SYNTHESES"

The following is a partial list of these preparations. Chemists interested in any of these preparations can procure copies from Frank C. Whitmore, Northwestern University, Evanston, Illinois.

Alloxan
α-Aminoisobutyric Acid
Ammonium d-α-Bromocamphor Sulfonate
n-Amylbenzene
β-Anthraquinone Carboxylic Acid
Benzoyl-o-benzoic Acid
Benzoyl Hydroperoxide
Benzyl Aniline
Biphenyl
Bromal
p-Bromobiphenyl
d-α-Bromocamphor
Bromotoluenes
n-Butyl amine
n-Butyl Carbamate
n-Butyl-p-Toluenesulfonate
Butyric and isobutyric Aldehydes
n-Butyryl Chloride
Cacodyl Chloride
n-Caproic Acid
Chloretone
o-Chlorobenzoic Acid
p-Chloromercuri Benzoic Acid
β-Chloropropionic Acid
α-Chlorostyrene
Dehydracetic Acid
Diacetyl Monoxime
3,5 - Diamino-4-hydroxy-phenyl Arsonic Acid
1,2-Dibromocyclohexane
Di-Iodofumaric Acid
Dimethyl Acetal
3,5 - Dinitro-4-hydroxy-phenyl Arsonic Acid
s-Di-o-phenetyl Thiourea
Ethyl Benzoyl Formate
Ethyl Cinnamate
Ethyl Nitrate
Glyceric Aldehyde
Guanidine Nitrate
Hydrocinnamic Acid
Iodobenzene
o-Iodobenzoic Acid
p-Iodobenzoic Acid
p-Iodoguaiacol
Mercury Diphenyl
Methyl-n-aldehydo-octoate
Monochloromethyl Ether
α-Naphthaldehyde
β-Naphthaldehyde
2,3,6-Naphthol Disulfonic Acid
α-Naphthoquinone
β-Naphthoquinone
Nitroacetic Acid
o-Nitroaniline
Nitroguanidine
Paraffin Hydrocarbons
2-Phenyl Benzothiazole
α-Phenyl-β-benzoyl Propionitrile
Phenyl Carbazole
β-Phenyl Cinnamonitrile
Phenylmercuric Acetate
Phenyl Nitromethane
β-Phenyl Propionitrile
Phenyl Succinic Acid
o-Phthalaldehydic Acid
o-Phthalyl Chlorides
Pinene Hydrochloride
Propionic Aldehydes
Pyrrole
α-Pyrrole Carboxylic Acid
Pyromellitic Acid
Resorcylic Acid
Silver d-α-Bromocamphor Sulfonate
Sodium N-Benzylidene-glycinate
Sodium Isonitrobenzylcyanide
Thienyl ketones
Thioacetanilide
Thioguaiacol
Thiophene
α-Thiophene Arsonic Acid
Thymol Mercury Compounds
o-Toluamide
o- and p-Toluic Acids
Tolyl p-Toluene Thiosulfonate
m-Tolylene Diamine
Trimethylene Chlorohydrin
Trimethylene Oxide
Triphenyl Amino
Triphenyl Stibine
Viscose



THE RELATION OF CHEMISTRY TO THE DEVELOPMENT OF THE PETROLEUM INDUSTRY

John William Urban, Armour Institute of Technology, Chicago, Illinois

Quotations

"The budding young organic chemist should be reminded that the reputations of most of the great organic chemists of the last century were based on the solution of problems connected with products from coal tar and that the time will come when some new Baeyer will open up the chemistry of petroleum products."[1]

"Petroleum affords a veritable mine of organic compounds. The magnitude of the industry is such that petroleum research should attract the best trained organic and physical chemists in our universities. Who can predict how far reaching both from economic and scientific aspects would be the result of a thorough scientific investigation in this almost virgin field?"[2]

"Coal tar was studied by the greatest investigators and the results aroused the admiration of the world. I believe petroleum offers the same possibilities. Let American chemists center their attention on the many fascinating problems awaiting solution in this field."[3]

THE RELATION OF CHEMISTRY TO THE DEVELOPMENT OF THE PETROLEUM INDUSTRY

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THIS paper proposes to show how chemistry has aided the practical refiner, and further, to outline how and why chemical research will become—as it evidently will—the most important factor in the future progress of the petroleum industry.

Chemistry and Industry

The success of most of the large industries in the United States today has largely been due to the efforts of the chemical engineer and the trained research chemist. Very few large industries that have survived to this day use processes that are not scientifically sound. It is apparent that a stable industry can only be based on correct natural principles, which, in turn, are the direct result of research.

JOHN WILLIAM URBAN

Silliman's Classical Research

Direct chemical contributions to the petroleum industry have been few. Up to about ten years ago, no big industry had been less dependent upon chemistry for its development.[4,*] A chemist, Professor Silliman, of Yale, furnished the first scientific information about petroleum; it was his recommendation that led to the beginning of the petroleum industry, in 1859.

Frasch and High-Sulfur Oils

Herman Frasch, the sulfur expert, was one of the few to really make a notable chemical contribution to the refining of certain oils. By the addition of copper oxide, which Frasch knew to have a strong affinity for sulfur, during the distillation of those Ohio and Indiana oils rich in undesirable sulfur compounds, he was able to satisfactorily remove the sulfur.

* Superscriptions refer to references on pages 696–7.

The value of those high-sulfur crudes was thus increased many-fold by this relatively simple application of chemistry.[2]

Research Neglected

But petroleum research, since these early days, has always been several laps behind the rapidly expanding industry. The chief reason for this was that the gasoline could not be marketed, and the liberal supply of lubricating oils, kerosene, and waxes to be found in petroleum made intensive research unnecessary. There was no incentive to improve the yields obtained.

Research Encouraged

Since the extreme demand for gasoline, and more particularly since the last few years of the World War, the petroleum industry as a whole has become a firm supporter of chemical research. Some of the larger concerns, such as the Standard Oil Company, have given considerable attention to research on petroleum problems for a much longer period, but it is only recently that comprehensive research programs have become a general rather than a rare occurrence.

More Gasoline Needed

The petroleum industry of the past has been based on the physical separation of the desired products. With the tremendous growth in the use of the gasoline engine, refining problems became centered on the production of sufficient gasoline to meet the demand. This could be satisfied by increasing the volume of crude run through the refinery, but premature exhaustion of available oil deposits would result, and besides, there was no adequate outlet for the large volume of heavier distillates. It became apparent that some chemical process was needed to obtain higher gasoline yields.

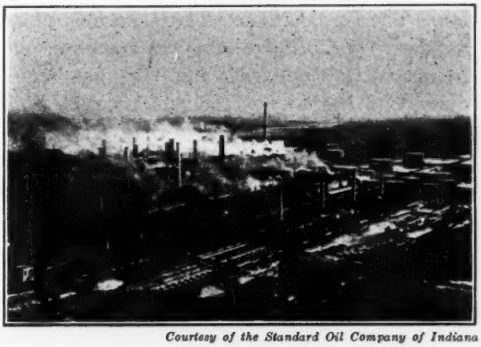
"Cracking" Processes Help

The chemist and the petroleum technologist, closely coöperating, succeeded in utilizing the general tendency of organic compounds to decompose when heated, in a process technically known as "cracking." The industrial application of this tendency, which has been partially solved, is the most outstanding development of the petroleum industry within the last fifteen years. From 1913 to 1924 the amount of crude run through the refineries increased 176 per cent, but the number of automobiles, during the same period, increased 1100 per cent.[5] Just how well the problem was solved can be seen from the fact that gasoline production kept pace with this expansion.

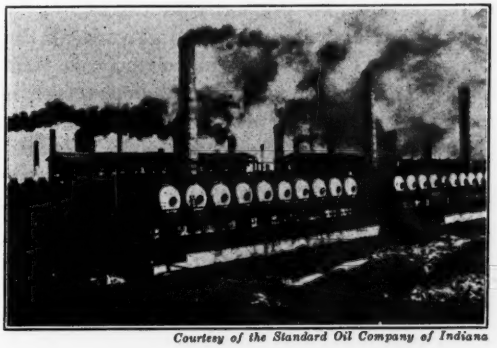
The Burton Process

The process devised by Burton, first patented in 1913, and since subjected to many improvements, ushered in a new era in the cracking of heavy petroleum distillates. It was the logical outcome of a series of experiments which were carried out on an increasingly larger scale, from stills of laboratory dimensions to the large pressure stills now used.

General view of an oil refinery. Note the battery of pressure stills, a closeup of which is shown in the next photograph.



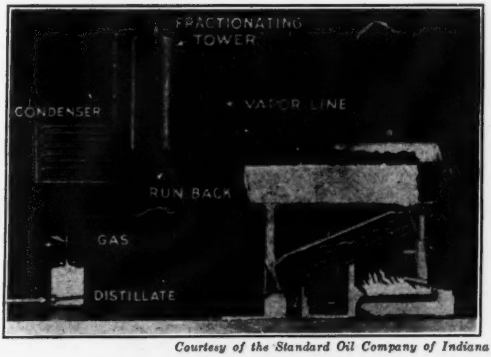
Courtesy of the Standard Oil Company of Indiana



Courtesy of the Standard Oil Company of Indiana

Battery of pressure stills, where cracking occurs. Chemical reactions take place within these stills, resulting in the formation of simpler hydrocarbons.

A diagrammatic view of a typical pressure still. In the Burton process, the cracking takes place in the liquid phase.



Courtesy of the Standard Oil Company of Indiana

The Burton process[6] is one of the most successful in commercial operation. The fact that such a large number of companies controlled by the Standard Oil Co. have installed cracking units, together with the large amount of the total gasoline yield that "cracked" gasoline comprises is evidence of the commercial and practical utility of the process, as well as of its scientific value. In 1913, the yield of gasoline from crude oil was about 12.5 per cent; in 1923 this yield was increased to 31 per cent.[7] In 1922 cracking processes were responsible for over a quarter of the total gasoline production.

The Rittman Process

The Rittman process,[8] developed during the war by Rittman, Dean, Dutton, and their co-workers of the the U. S. Bureau of Mines, presents many significant features. The process employs moderate temperatures and high pressures if gasoline is desired, and it has the further advantage of yielding considerable quantities of aromatic hydrocarbons, such as benzene, toluene, and xylene, under different temperature and pressure conditions.

Bureau of Mines Doing Good Work

The Bureau of Mines carried out their experimental work at the Columbia University laboratories. Five typical petroleum oils were subjected to a wide range of pressures and temperatures, and the results carefully noted. Favorable and unfavorable conditions alike received detailed attention, for their main purpose was to secure comprehensive data, rather than data on the production of any single hydrocarbon. Such work is of fundamental importance, and the Rittman process, which is a result of it, is an example of what can be expected from a continuation of such extensive chemical research. The Bureau of Mines is leading the attack on the many complex problems which confront the petroleum industry at every turn.

Problems Are Complex

In spite of the commercial success of these processes, little is yet known about the chemical and physical changes involved in the heat treatment of hydrocarbons. Admittedly they are difficult—there are few industrial operations that are more complex in character—and they present a wide range of problems to the trained chemist as well as the practical refiner. Until more of the fundamental principles involved are known and recognized, maximum recovery of desired products from cracking processes can hardly be attained. Research in the next few years will see many fruitful results, not only along these lines, but in every line of attack that the refiners are vitally interested in.

Consumers have always taken a dislike to cracked products. This prejudice was said to be based on the claim that cracked gasoline was inferior to the first-run product. Treatment with sulfuric acid eliminates most of the odor and color, but the gasoline has a tendency to

Cracked Gasoline Better

acquire a dark color on standing. One of the chief objections to cracked gasoline is the fact that it causes a heavy deposit of soot in the cylinder of an engine, but, as Hall points out,[9] this is probably due to improper combustion conditions because the nature of the cracked gasoline is unknown. His work seemed to show that cracked gasoline is more efficient in internal combustion engines than ordinary gasoline, due to its slow burning properties. This distributes the power imparted to the piston over the entire stroke, and prevents knocking.

The fact that not all cracked gasolines have antiknock properties suggested a line of research for petroleum chemists. The Pittsburgh

Antiknock Gasolines

laboratory of the Bureau of Mines, together with the research staffs of many of the large companies is diligently working on this problem. There are two general lines of attack: either some chemical is necessary which, when added to the gasoline reduces the knock, or the antiknock properties must be inherent in the gasoline. Both are typically chemical problems; the latter is the most difficult, as it requires a considerable knowledge of the chemistry of oil refining.

Thomas Midgley, Jr., one of the technologists in charge of the General Motors Corporation research, with his assistant, T. A. Boyd, made

Midgley and Tetraethyl Lead

the discovery that tetraethyl lead is a satisfactory antiknock compound.[10] The Standard Oil Company of New Jersey also aided in the development of this compound. Should the use of antiknock gasolines become universal, it would be possible to employ high compression engines, which are more efficient than the engines now in use. Due to an unfortunate accident attending its manufacture, tetraethyl lead has been withdrawn from the market pending an investigation by health authorities and prominent chemical engineers.*

G. L. Wendt, formerly in charge of research for the Standard Oil Company of Indiana, and Grimm have carried on some very interesting

Work of Wendt

experiments on the mechanism involved in the retarding of the combustion of air-gas mixtures by antiknock compounds.[11] They have proposed an electronic explanation. They explain the propagation of the explosion in a gaseous mixture as due to the presence of free electrons that travel ahead of the flame front and act as detonators. The heavier metals are known to absorb free electrons readily, and these workers suggest that it is the absorption of these free electrons that retards the velocity of the flame front and accounts for its antiknock properties.

Several refining companies within the last few years have been working

* Since this paper was written a report favoring the use of ethyl gas has been made.

independently on the problem of obtaining cracked gasoline of superior antiknock qualities. Their technologists are convinced that any effort expended along these lines has not been wasted. It appears from data now available that saturated paraffin hydrocarbons are the least desirable constituents of an antiknock gasoline. Unsaturated olefins, terpenes, and aromatic compounds, such as benzene, having the same boiling range as ordinary gasoline, account for the antiknock properties. In other words, the larger the percentage of hydrogen in a fuel, the better the chances are for knocking. This may possibly be explained, as Cross points out,[12] by the fact that in gaseous mixtures of hydrogen and oxygen, the higher the percentage of hydrogen present the more rapid is the propagation of the explosion through the mixture. One of the functions of an antiknock compound is to slow down this high propagation velocity, so that the energy is not expended practically instantaneously.

Antiknock Research Yielding Results

The general method of treatment with sulfuric acid removes many of the antiknock substances from gasoline, thus radically different methods for treating cracked motor fuel are necessary before much advance can be made, and chemists already have proposed numerous substitutes. Fuller's earth and similar absórbents have been tried for treatment in the vapor phase, and several refineries are eliminating sulfuric acid treatment in this way.[13] All of these possibilities which cracking processes hold offer interesting as well as important subjects for extended chemical investigations.

Cracking Has a Future

Probably the biggest reason why more efficient methods of production and refining have not been devised is that the work which only a chemically trained expert could hope to perform has been left for the mechanical engineer or the practical petroleum technologist to do. The organization of an industry minus the services of chemistry is no more complete than an internal combustion engine without its spark-plugs. For chemistry is really an important factor in the petroleum industry, and until it is utilized to this extent considerable loss and otherwise preventable waste will occur.

Chemistry Essential to Industry

It is the complex nature of the products and processes that has retarded to some extent chemical research on the subject of petroleum hydrocarbons. Such work of a pioneer character, when carried out on an extensive scale, will benefit the entire industry. Imagine an industry in which it is estimated that over nine billion dollars is invested, working with a substance about which it knows practically nothing. Bacon[14] expresses this point in the following words:

R. F. Bacon Says Something

"One can read in scientific literature pages and pages describing the properties and chemical reactions of hydrocarbons of which at most a few hundred grams may have existed in the whole world, while tons and thousands of tons of hydrocarbons are being produced daily of which we know absolutely nothing regarding their chemical properties, their reactions, and their structure."

Treatises and laborious works on the chemistry of the petroleum hydrocarbons, with few exceptions, list hundreds of compounds which have been isolated from petroleum, and about which are known little else than their physical properties. In some cases not even the physical properties are accurately known. Tables containing these constants vary widely.[15] In one table the figure given for the melting point of normal octane is 98.2°C., while Fororand,[16] as a result of a recent determination, gives it as 57.4°C. No wonder confusion exists.

Petroleum Composition Uncertain

The composition of petroleum is uncertain. Petroleum probably contains hydrocarbons as high in the paraffin series as $C_{25}H_{52}$, in addition to many cyclic naphthenes, about which little is known. As B. T. Brooks and other advocates of extensive chemical petroleum research have pointed out, the lack of a theoretical knowledge of the non-benzenoid hydrocarbons is the greatest drawback to chemical expansion.

Mixtures or Pure Substances?

Furthermore, it is doubtful whether most of the individuals described are individuals rather than mixtures. The work of Young and his co-workers,[17] which is considered as some of the most careful work done on the composition of petroleum, has shown how difficult it is to isolate perfectly pure substances from petroleum, Thus, in a mixture of pentane and isopentane, whose boiling points are 8.4° apart, thirteen fractional distillations in a special apparatus were required to separate the two.

Pioneer Petroleum Chemists

These few pages, however, are not intended to convey the idea that chemical research on petroleum has been entirely neglected. They merely point out the many possibilities that have not yet been subjected to rigorous investigation. There have been at work within the past fifty years, engaged in researches of a fundamental character, a small group of remarkably able chemists, and no discussion of the relation of chemistry to petroleum would be complete without mentioning their names. This group includes Warren, Coates, Mabery, Sadtler, Peckham, Storer, and others and their efforts have resulted in a voluminous literature of immense importance in this field. In fact, it may be said, that the chemical knowledge of American petroleum today, relatively small though it may be, is directly due to these earnest and sincere workers.

The need for research is recognized by leaders in the chemical world. Dr. James F. Norris, in a recent address,[3] came directly to the point when he urged the universities to coöperate with the industries in general, and the petroleum industry in particular, on problems of pure research. He urged academic investigators to devote their energies to the solution of the many pressing problems in this field and recommended that "they be approached in the same spirit that led to the triumphs attained in aromatic chemistry."

Research Endorsed by Norris

This will require the concentrated efforts of great numbers of university men over a considerable period of years. The study of petroleum compounds will be much more difficult than the study of coal-tar derivatives, for in the case of the latter the substances can be readily isolated, yielding crystalline derivatives that are easy to purify and handle in small quantities. The university is the place for such work. Walker is more than right when he said that the symbol of the industrial laboratory is the dollar mark, and such laborious study is not directly convertible into money. The value to the entire industry, however, is not measured solely on the ground of the utility of the results. B. T. Brooks, one of the authorities in this field, recognizes this when he says: "A great deal of painstaking, systematic research in the field of the non-benzenoid hydrocarbons must be carried out which may never be utilized directly in an industrial process."[18]

B. T. Brooks Quoted

The question of what makes a lubricant is still unanswered. The only test known so far is to try it out on the machine and see. With lubrication such an essential part of industrial activity, the ignorance that prevails on scientific lubrication is astonishing. Mabery has prepared fractionated samples of lubricating oils, one fraction that was satisfactory as a watch lubricant, while the next fraction, when applied, caused the watch to stop. And yet there are no physical or chemical tests known that will distinguish between those samples so far as their qualities are concerned. The selection of a lubricant for a particular purpose is thus "more casual than scientific."[14]

What Makes a Lubricant?

Lubrication Unscientific

Within recent years there have been plenty of indications that petroleum is a potential source of raw materials for the chemical industries. Formerly petroleum was associated with gasoline, lubricating oils, kerosene, and paraffin. The service of the chemist has enabled this list to be materially enlarged, so that in the near future it will include dyes, soap, medicines, alcohols, and probably rubber. Due to the stimulation afforded by the recent war, there is a large demand for organic derivatives.

A Source of Organic Derivatives

If present achievements are any indication, petroleum will soon be furnishing commercial quantities of olefins, cyclic compounds, and saturated paraffins.

Many of the compounds do not exist as such in the oil, but by controlling the distillation conditions the yield of desired products can be partially regulated. This, it may be noted, is one of the ultimate aims of chemical research in this field, for if the conditions controlling the production of various substances are fully known, then refineries will be in a position to supply the market with whatever product is in demand at the time. This will eliminate waste and increase the operating efficiency to a maximum. To be sure, much of the work is still in an elementary stage of development, but with the large amount of research now under way it should not be long before such possibilities are realized. When it is commercially practical to obtain organic substances from petroleum, there will be a ready market for them, since large quantities are used annually in the manufacture of explosives, varnishes, paints, lacquers, solvents, and photographic chemicals.

Aim of Petroleum Research

Synthetic alcohols can now be made from petroleum.[19] One way is to separate the olefins resulting from the destructive distillation of certain fractions by treatment with sulfuric acid and hydrolyzing the sulfuric esters thus formed. These alcohols will find wide use as solvents in the making of artificial silk, films, imitation leather, and waterproof compounds. This process also results in the formation of the complex secondary and tertiary alcohols which are not readily obtained from other sources.

Synthetic Alcohols

A significant example of how chemistry aids the refiner is found in the recent achievement of the Standard Oil Company of New Jersey, and the Empire Refineries, Inc.[20] They have devised a process for converting unsaturated hydrocarbon gases from the cracking stills, formerly used as fuel to heat the stills, into isopropyl, amyl, and some of the higher alcohols.

At the American Chemical Society meeting in April, 1925, Dr. C. H. Herty,[20] one of the leading American chemists, emphasized the importance of the chemist in developing these new processes. He believes, and he is not alone in his opinion, that the chemistry of the methane, ethylene, and acetylene series should be expanded, for large quantities of these substances will soon be available from petroleum at a low cost.

There is also more than a remote possibility that rubber will be made on a large scale from petroleum.[19] Already it has been made experimentally from polymerized diolefins, such as butadiene and isoprene, a form of which is the gum that occasionally interferes with the operation of cracking stills and carbureters using cracked

Rubber?

gasolines. The main drawback in the synthesis of artificial rubber has been a cheap source of butadiene. Petroleum is a potential source. The synthetic rubber obtained is comparable in every respect with the natural product; cost presents the only difficulty.

Drying Oils

The preparation of true drying oils from petroleum is another problem in which intelligent research should bring results.[21] Considerable attention has already been given to it. The drying oils are characterized by double bonds that absorb oxygen during the drying period, with the formation of a firm, elastic film. A method of making these double bond compounds will involve a considerable knowledge of organic synthesis. By suitable chlorination and treatment, a drying oil that compares favorably with linseed oil can be prepared from petroleum. According to several German patents,[21] chlorination is also one of the main features in a process of making synthetic resins that are cheaper than the phenol-formaldehyde plastics.

Fatty Acids and Soaps

Perhaps the most difficult task that confronts the chemist is the large scale production of fatty acids, ketones, and aldehydes from the higher petroleum hydrocarbons. The acids will be useful in the manufacture of soap and work has progressed far enough in this direction for Dr. Norris to predict that this source will provide the soap for several future generations.

Several Sulfur Dyes

The production of dyes from petroleum is yet an open field for research, but Frasch has succeeded in preparing several dyes of a different nature than the aromatic dyestuffs. Frasch,[22] as long ago as 1893, took out several patents dealing with the production of a brown and a yellow dye from petroleum. By the nitration of the higher fractions of a Galician petroleum, a brown substantive dye can be prepared by the action of an alkali, while with sulfur and alkali, a brown-violet dyestuff results. So that the production of dyestuffs from petroleum is not so imaginary as it may appear at first.

Ichthyol

Ordinary petroleum does not possess any particularly health-giving properties. But by retorting shales, distillates rich in sulfur are obtained which, when sulfonated and prepared in the form of the water-soluble ammonium salts, go by the name of ichthyol.[18] This has marked medicinal properties and is used on skin sores, the same use that Marco Polo saw the crude Baku petroleum put to on his travels to Far Cathay, where it was the custom to smear the oil on the sore backs of camels. Other derived medicines will undoubtedly be developed.

In the production and refining of petroleum, considerable material is lost through the formation of emulsions. The breaking up or prevention

Losses Due to Emulsions

of these emulsions is a problem for the colloid chemist, and is no easy one. The annual loss due to these emulsions has been conservatively estimated at well over a million barrels.[23] Substances are now used which help to break up the emulsion. Some solid mixtures, consisting for the most part of sodium oleate, have been used with some success, a one per cent water solution being the most effective. A liquid compound, the sodium salt of sulfonated oleic acid, was developed after many experiments and is widely used. The one serious objection to these substances is that they require water as a solvent. Oil-soluble compounds of similar properties would obviously be more advantageous and the search for such a substance is now under way.[24]

Production and refining losses involve a fair portion of the total production, so that chemical studies as to how these losses may be reduced

Evaporation Losses Are Large

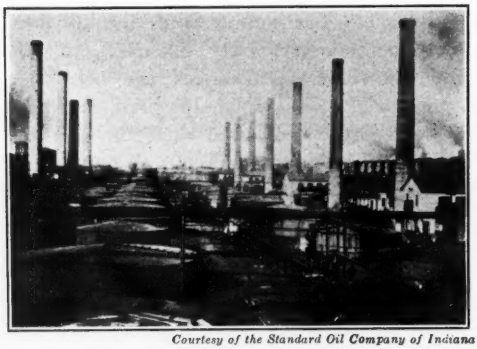
to a minimum are not out of place. When gasoline is stored for any length of time in storage tanks, losses due to evaporation and breathing assume large proportions. In 1922, according to Wiggins,[25] the loss by evaporation, from the well through the refinery, amounted to about $250,000,000. This would just about pay for all the Fords produced during that year. The research department of the Standard Oil Company of Indiana has recently been experimenting on specially constructed balloons, made of gasoline-impervious cloth, which catch the expanding vapors and prevent their escape into the air. The cloth used in their construction was evolved after considerable research.[26] A fabric impregnated with gelatin, glycerine, and water was found satisfactory. The first few installed proved so successful that during the summer of 1925 over sixty more were put into use.

It is recognized that the greatest need of those engaged in the industry today is a standardization of testing methods, which includes both the

Standard Testing Methods Needed

procedures and the technic. Already considerable revision has occurred in the analytical methods applied to petroleum but more work will be necessary before precise and detailed operations of general applicability are worked out. Even now some confusion exists in the industry, due to the wide variety of "standard" tests; samples which are acceptable by one method are rejected on the results of another. The American Chemical Society has had for several years committees, composed of representative petroleum chemists and others in direct contact with the industry, working on these problems and existing methods have been made the subject of critical study. As a result of this work many new standards have been adopted.

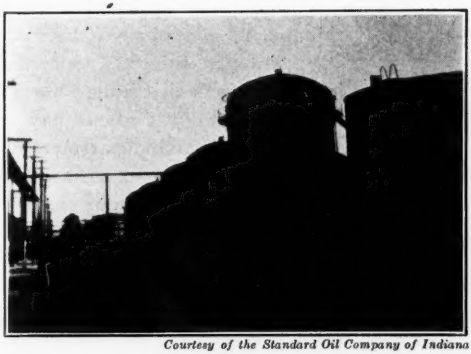
Oxidation products, produced by the catalytic oxidation of gaseous



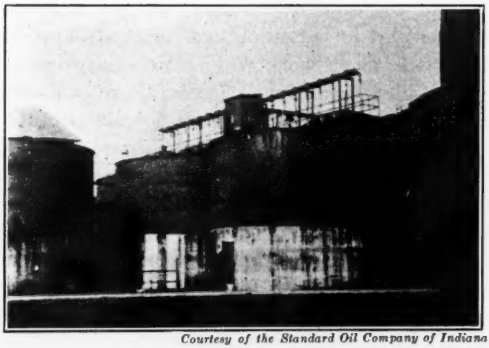
Courtesy of the Standard Oil Company of Indiana

$250,000,000 was the annual loss by evaporation from gasoline tanks similar to these. Chemical research has developed methods of reducing this waste.

In these sludge separators, a considerable gasoline loss is caused by the formation of emulsions, another problem which the chemist is attacking.



Courtesy of the Standard Oil Company of Indiana



Courtesy of the Standard Oil Company of Indiana

In these naphtha agitators crude gasoline is refined by mixing with concentrated sulfuric acid. Vapor phase treatment with Fuller's earth is now replacing this wasteful method.

fuel oils at low temperatures, offer a broad range of possible commercial applications. It appears from the work of James[27] and others that a whole series of novel oxidation products, with many uses, result when proper temperatures and catalysts are used. In this connection, the metals of high atomic weight, such as uranium and molybdenum, appear to yield the best results, while temperatures ranging from 300° to 500°C., preferably in the neighborhood of 400°, are best suited to promote the reaction. The products vary, of course, with the conditions, but in general they represent all the stages of oxidized aliphatic compounds, from alcohols and aldehydes to oxygenated acids. The higher fatty acids obtained in this way, when saponified with a caustic alkali give soaps, but when the liberation of the free acid is attempted by treating the soap with a mineral acid, hard resin-like substances appear that may prove useful as cheap varnish gum and paint film substitutes. When weaker bases, such as calcium hydroxide, are used good soaps are obtained, and by proper precaution, unresinified substances are secured. The portion comprised of unsaponifiable compounds is, according to James, a logical source of good lubricants. Other products will result when the study is extended; as for the present the production of such substances has hardly yet reached even the semi-industrial stage.

Catalytic Oxidation Products

From a theoretical viewpoint, the utilization of petroleum as a source of valuable by-products and chemical raw materials is not limited to soaps, dyes, paint, and varnish bases, solvents, medicines, or even rubber. Enough nitrogen compounds are present, with traces of sulfur, to form the materials from which future chemists may make proteins and other foods.[28] But this paper has attempted to limit these fanciful flights to more or less material products whose existence and production have already been demonstrated on a laboratory scale. Those topics which have been briefly discussed in this paper by no means exhaust the possibilities. There are numerous other problems in which the chemist is playing an important role. At the present the greatest need seems to be research dealing with the mechanism of basic reactions. Fortunately, the oil industry as a whole has come to realize this; it can almost be said that a new spirit permeates the industry—a spirit that demands a thorough study of the fundamentals upon which oil refining is based.

Importance of Fundamentals Recognized

With respect to the chemistry of petroleum, it may be remarked that the possibilities are unlimited. Many industrial as well as university research laboratories are now studying the reactions formerly characterized in chemical treatises as insignificant with the expectation that these reactions will lead to results of industrial value. Statements made

Future Possibilities Unlimited

ten years ago—that paraffins enter into no chemical reactions—are gradually being modified, not because their small reactivity has increased any, but because it is now regarded as being significant of future possibilities.

Concluding Remarks

The day of empirical methods is past, and with the introduction of rigorous scientific principles, it is not difficult to visualize a growth that will even surpass that of the last decade. For the nourishment of this growth it is essential that there be an increment in research; then will the petroleum industry reap the benefits of what Huxley has termed "the swift acceleration of scientific research."

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A TRIBUTE TO HERBERT F. DAVISON

At the one hundredth meeting of the New England Association of Chemistry Teachers a committee, consisting of Lyman C. Newell, Arthur H. Berry, and Shipley W. Ricker, presented this tribute to Herbert F. Davison. It was read while the members stood with bowed heads. At the close it was voted to spread it upon the minutes of the meeting and to send a copy to Mrs. Davison.

"The death of Herbert F. Davison has removed from the New England Association of Chemistry Teachers a man whose generosity and ability had won our deepest admiration and genuine esteem.

"As Chairman of the Southern Division and later Vice President, he was an industrious and energetic officer of this Association. His many contributions to our programs, always so willingly made, will long be remembered by us for their specific originality and immediate usefulness.

"As a demonstrator of lecture experiments, Mr. Davison was unsurpassed. As a college teacher, too, he was a constant inspiration to his students and maintained their interest not only by his skill as a lecturer but also by his keen appreciation of their needs as learners. His success as a teacher was due largely to the fact that his mastery of his subject and skill in presentation did not cloud his conception of the difficulties of beginning students.

"Mr. Davison was a modest man and no doubt this trait delayed somewhat the professional recognition of his marked ability as a teacher.

"The New England Association of Chemistry Teachers desires at this time and in this way to make a formal and permanent record of its loss."

THE TRAINING OF HIGH-SCHOOL CHEMISTRY TEACHERS

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Many teachers look back upon their first year of teaching with a feeling that it was largely a period of trial and error in which many mistakes were made, usually at the expense of their students. Effective teaching of any kind, and particularly the teaching of chemistry in the secondary school, demands a well-organized knowledge of subject-matter and considerable technic in the method of presentation. This proficiency, in the case of the majority of teachers, is gained in the hard school of experience.

A few institutions are attempting to give some preparation to prospective teachers of high-school chemistry, by offering courses designed specifically to that end. Glenn[1] has recently pointed out the need for general information as to the details of these courses:

"What are the present teacher-training facilities with respect to chemistry in typical states? If courses are given dealing with the teaching of high-school chemistry, what do these courses include and what should be included?"

The writer has outlined a course, "The Teaching of Chemistry," which is based largely upon problems drawn from his own experience in teaching chemistry in the secondary school. It is a study of the real problems met with in the class-room. The course (three hours weekly for one semester) was first offered in 1924 by the Department of Chemistry of the Pennsylvania State College. The course is elective for students in the School of Education and the School of Chemistry and Physics at this institution and will be given in the coming summer session which is attended largely by teachers. One of the students in the class this year is acting as laboratory assistant and is thereby receiving actual teaching experience.

The following outline of topics is used in the course described above:

I. History of Instruction in Chemistry in American Schools.

A brief study of this topic is undertaken for the purpose of giving the student a knowledge of the factors which have contributed to the development of our modern courses in chemistry.

II. Aims and Content of Instruction (General).

1. Analysis of the present-day courses into general sub-divisions, *e. g.*, theory, practical applications, etc.
2. Relative percentages of students who do and do not attend college; influence of this factor on the kind of instruction given.
3. Various syllabi of courses.

III. Survey of Subject-Matter (in Detail).

This work occupies considerable time. A standard elementary

[1] Earl R. Glenn, THIS JOURNAL, **2**, 670–6 (1925).

text-book is used with frequent reference to other books and articles in the literature.

The viewpoint is that of:

1. The pupil's everyday experience.
2. Necessary background of the teacher.
3. Method of presentation.

Special attention is given to certain topics, *e. g.*:

1. Acids, bases, salts.
2. Ionization.
3. Chemical calculations.
4. Conservation of matter and energy in chemical changes.
5. Valence.
6. Writing of formulas and equations.
7. Kinetic theory of gases with applications to elementary work.
8. Structure of matter.
9. Demonstration technic.

IV. Chemistry in the High-School Curriculum.

1. What is the proper time allowance for recitation, demonstration, and laboratory work?
2. In what year of the high-school course should chemistry be taught? Why?
3. Should it precede or follow physics?
4. What is the present trend as to the number of students enrolled in these two subjects?
5. What is a desirable sequence of science for the four years?
6. How can a chemistry teacher coöperate with other teachers?
7. How many teaching hours should be expected?

V. Special Problems.

1. Comparison of recitation, demonstration, and laboratory work as effective means of instruction.
2. Proper sequence of the above methods.
3. Should boys and girls be placed in separate classes?
4. Examinations in chemistry.
5. Note-books and laboratory manuals.
6. Use of the project method.
7. Use of the inductive method.
8. Lesson planning.

VI. Laboratory Construction, Equipment and Maintenance.

1. Location, lighting and ventilation of the laboratory.
2. Design of tables, drains, and storeroom.
3. Purchase of supplies.

4. Storage, dispensing, and disposing of chemicals.
5. Projection equipment.
6. First-aid equipment and responsibility of the teacher in case of accidents.
7. Attitude of the teacher in laboratory work.

VII. Professional Advancement of the Teacher.

1. What other subjects may he be expected to teach?
2. What organizations are helpful?
3. Teachers' literature.
4. Should research or analytical and consulting work be done?
5. What formal study should be done?
6. Various fields for promotion.

It should be emphasized again and again that high-school chemistry is for the most part a means to an end rather than an end in itself. We must teach our high-school pupils a type of chemistry that will be of real value both as to *what* is learned and *how* it is learned if we are to get results commensurate with the time and expenditure allotted to it. To accomplish this purpose we must give more attention to the training of our teachers.

Blue and Red Flowers Colored with Same Dye. It makes no difference whether a flower is red or blue, its hue is due to the same fundamental substance. Its redness or blueness depends on the chemical nature of the plant sap. For example, deep red dahlias and blue cornflowers contain the same pigment, but the sap of the dahlias is acid and that of the cornflowers is alkaline and this makes all the difference. Intermediate shades depend on the degree of acidity or alkalinity.

The name of this versatile plant pigment or dye is "anthocyanin," according to Prof. R. Robinson, well-known English physiological chemist, who told of investigations in this branch of plant physiology before the Royal Institution of Great Britain. This strange-looking word is made up of two simple Greek roots, which translate into "flower-blue," which is exactly descriptive of one of its phases.

There are really many distinct anthocyanins, Prof. Robinson explained, though chemically they are practically identical. By analysis they can all be shown to be derived from three fundamental substances, which are closely related to each other.

There appears also to be a fourth member of this group of basic flower dyestuffs, which has long been exploited by tropical Indian tribes as material for rouge, which, however, is used among them by gentlemen only.

"The Indians of South America in the vicinity of the Orinoco prepare a red plant pigment called 'carajura' or 'chica,'" Prof. Robinson told his hearers. "It is so valuable a commodity that it is said of a poorer native, 'he can only paint half of his face.' The chemical examination of carajura by Prof. A. G. Perkin has resulted in the isolation of a red crystalline constituent called carajurin. The molecules of the salts of carajurin with acids have been proved to contain the characteristic nucleus of the anthocyanidins and apparently carajura proclaims a fourth anthocyanidin. It is unique both as a cosmetic and as an object of scientific research."—*Science Service*

SHOULD LABORATORY COURSES REQUIRE MORE OF THE STUDENTS' TIME PER UNIT CREDIT THAN LECTURE COURSES?

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There appears to be a common practice in all of our educational institutions of allowing credit of one unit for a lecture period of one hour and the same credit for an hour recitation. When laboratory work is considered there is a variable scale of 2 to 3 or more laboratory hours' requirement for each unit of credit. The supposition in the matter is that for each lecture or recitation period the student does from one to two or more hours of preparation work outside of the class-room. In a majority of our institutions a three-hour laboratory period is deemed equivalent to one lecture or recitation period on the above supposition. In the analysis of this latter supposition we will take two extreme cases to bring out the injustice to the student in the unit credit for laboratory courses.

Two students of equal ability have elected fifteen semester hours of work, one entirely in lecture and recitation courses, the other in laboratory courses. The student in the lecture work attends three classes a day beginning at 8 A.M. His work is completed at 11 A.M. The preparation for this work seldom requires more than an evening study per day, most of this study being devoted to the recitations during the week. The other student has to devote forty-five hours per week to the laboratory, and for the greatest efficiency must do outside additional study. Considering that this latter work is unnecessary, he has to begin his work at 8 A.M. and concludes the work at 5 P.M., allowing an hour for lunch at noon. His friend's study averages 3 hours per evening—8 P.M. to 11 P.M., making a total of 30 hours of application for a 15-hour credit while the laboratory student does 45 hours of work for the same credit. The actual ratio of work is 30 to 45 rather than 30 to 30, as it should be. A 30 to 30 ratio would be obtained by allowing one unit credit for two hours' laboratory work.

The unfortunate situation of the laboratory system is that there appears to be a lack of uniformity in the different branches of science. As to the supposition that in certain laboratory courses outside preparation is necessary whether it be an analytical course in chemistry or a laboratory course in physics, zoölogy, mineralogy, or other sciences taught by the laboratory system. A number of our institutions have apparently recognized this fact and have uniformly given a unit of credit for two hours' laboratory work. Others, and this number in majority, consider a three-hour laboratory period in all sciences as being equivalent to one unit credit, the supposition being that no outside work is necessary and that two hours' preparations are required per hour lecture or recitation.

In the study of the subject the author of this paper wrote to the heads of the chemistry departments of forty of our leading institutions in the

United States. The table that follows is a compilation of a portion of the data thus obtained. In addition to the requests for the data regarding laboratory credits in the representative sciences, the author asked for opinions regarding the hour basis, whether this basis should apply to all sciences, opinions regarding the theory that two-hour study was required or indulged in for one-hour lecture, and whether outside work was required for laboratory courses. The majority of the chemistry professors desired a three-hour laboratory period, but a number of these owned that the two-hour study basis for lecture or recitation was seldom indulged in except in the preparation for an examination. The majority of replies to the common basis of laboratory credit in all sciences were in accord as to this requirement, although a few claimed that this depended upon the courses, some requiring more outside preparation.

If it were possible to have a uniform requirement of total credits for graduation in our universities, a common basis of credit for similar courses would be very desirable. The contention against such a standardization would be in the fact that some institutions are better equipped to conduct certain courses than others. We would here suggest that courses should not be offered if the equipment is inadequate for work which fulfils standard requirements in the course. Let more effort be placed on undergraduate work of uniform requirement in all our institutions. The schools that have the equipment and the financial backing to carry on the work, and they alone, should undertake advanced courses. Here, again, however, there should be a definite laboratory hour requirement per unit credit. This, the writer believes, should be not over $2^1/_2$ hour period per hour unit credit on the basis of 1 hour unit credit per hour of recitation.

In dealing with the instructor's teaching load, greater liberality in credits is necessary. For efficient work 2 units load should not require more than a 3 hour laboratory period. This would mean, furthermore, that the instructor should not be required to give his time to more than 15 hours of laboratory instruction. This would be five afternoons per week of five days and an additional daily lecture or recitation or quiz making a total of 15 units load. The additional outside preparation for efficient work on the instructor's part will make his day a busy one on the above plan. It would be very desirable to cut down this requirement for the one who has the inclination for research work. Such work should be encouraged and recognized on the basis of not over 2 hours of research in the laboratory per unit load credit. Supervisional work for advanced students should be considered in the instructor's load as such work requires considerable thought and frequent outside study on the part of the instructor. This supervision should be given during consultation office hours, which should count hour for hour in instructor's credit load, a daily office hour, during

five days per week, being credited 5 units load. In a questionnaire submitted to instructors in our leading institutions a large majority believed in a more liberal schedule than is suggested above, many suggesting that the unit load credit should be hour for hour in laboratory work, or 15 hours unit load credit for 5 afternoons of laboratory work of 3 hours each. A discussion on this subject is solicited.

The difficulty in getting a common basis of comparison, due to different credit systems, quarterly, triad, and semester plans has made it necessary to adopt here a system of averages and group the schools as follows:

A. Institutions having an uniform standard of one unit credit for two hours' laboratory period, making two hours' laboratory equivalent to one recitation or lecture.

B. Institutions having a definite requirement of three hours' laboratory period equivalent to one recitation or lecture.

C. Institutions having a variable requirement of either two hours or three hours according to the courses.

D. Institutions having two, two and a half, and three-hour laboratory periods equivalent to one recitation or lecture period.

A Class—Drake U., U. Pennsylvania, U. Vermont.

B Class—U. Arizona, U. Cincinnati, U. Colorado, U. Idaho, U. Iowa, U. Louisiana, Mass. Institute of Technology, U. Michigan, Stanford U., U. Utah.

C Class—U. Arkansas, U. Chicago, U. California, Harvard U., U. Illinois, New York U., Ohio State U., Ohio Wesleyan U., Princeton U., U. Southern California, U. Tennessee, U. Virginia, Western Reserve U., St. Louis U., U. Maine.

D Class—Columbia U., Cornell U., Northwestern U.

The University of Southern California has under consideration a plan to adopt a two-hour laboratory period for all Freshman laboratory courses, and a two and a half hour period for all advanced courses beginning with the Sophomore year. This requirement will be uniform in all branches of science where laboratory work is required.

Salmon Found Good Goiter Preventive. Canned salmon is the latest addition to the list of "healthy" foods we are urged to eat. N. D. Jarvis and Drs. R. W. Clough and E. E. Clark of Seattle report to the American Medical Association that salmon, both fresh and canned, on account of the amount of iodine it contains, should be as effective a preventative of simple goiter as milk products, fruits and leafy vegetables.

Analysis of various foods undertaken at the University of Washington shows that while several sea foods such as seaweed, oysters and lobsters, have more iodine than salmon, the latter is the cheapest and most available food of a high iodine content on the market.—*Science Service*

FOUR-, FIVE-, AND SIX-YEAR CHEMICAL ENGINEERING CURRICULA*

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As a training there can be no question five years are better than four and six should be better than five. If there were no collateral factors there could be no further discussion of this question. To be somewhat thorough we would, of course, investigate the possibility of entertaining opposing views. As a matter of fact we were all brought up face to face with several factors which make other points of view not only tenable but useful. If the school could produce chemical engineers, even these collateral factors would scarcely ever become dominant. As the chemical engineer is developed only on the job, the effort of the schools is consciously aimed at a thorough foundation and introduction. No one expects the graduate of a six- or eight-year law or medical school to be a lawyer or a doctor. They must practice. Some very useful effort has been made in chemical engineering education quite in advance of most forms of technical training, to inject some practice directly into the curriculum.

This set-up of the educational problem makes clear that the question of length of course is complex. It may serve some useful purpose therefore to recall in a sketchy manner some phases of a few of the collateral factors which serve to influence the tentative solution of the four-, five-, or six-year curriculum question. As far as any given institution is concerned the solution of any such question is usually a tentative one merely. Hence the value of free discussion.

Four years is the ordinary standard length of university and technical education in America. Longer formal study or training, however, is gradually increasing in demand. This demand comes from students, teachers, and industry. Students, without doubt, will follow custom or opportunity. Teachers will follow and recommend the need, as their experience sees it and as discussion develops the matter. Teachers of technical subjects such as chemical engineering and industrial chemistry will at least be independent and impartial in any decision regarding length of course. If anything, their personal feelings will incline toward longer training since they meet only advanced students, and on the average the longer course will tend to have fewer students in the advanced years, reducing teaching load.

Extended Curricula Tendencies

Extension of curricula has long been in progress. Many of us can remember the day in our university or technical schools when special courses

* Read by invitation of The Committee on Chemical Engineering Education of the American Institute of Chemical Engineers at the Conference on Chemical Engineering Education under the auspices of the American Institute of Chemical Engineers, March 26, 1926, Columbia University, New York City.

were operated. There were the short courses, so called, especially adapted to mechanics and other workers who had late in life discovered the need of educational breadth along with special technology. There were also the special courses, one, two, or three years in length, generally the latter, which supplied the demand from a similar group who often had the requisite entrance requirements lacking in most of those who entered the short courses. The students in the special courses were usually men of snap and vigor, who also had entered college after the normal time, though not so late as the short-course students, but who did not care for a degree, and who usually omitted general or cultural subjects.

Neither of these arrangements led to a degree, and both of them included students fresh from the high school, as well as the groups mentioned. Both of them also produced many men who are now leaders in the chemical engineering world.

The regular high- or preparatory-school graduate who entered the university or technical school usually pursued the longer course leading to a degree at the end of the fourth year. He was classed as a regular student and looked upon as such. He comprised all variations of ability and possessed varying appreciation of opportunity. He quite frequently was merely continuing his education, with little definite appreciation of the meaning of it all, since he usually had not supported himself.

The short and special courses have gradually been extinguished for various reasons. No educational procedure is necessarily final, and the extinction of short or special courses does not mean that they should not be revived should adequate reason present itself. However, it is the general feeling at present that chemical engineering students should, if possible, be given the standard four-year curriculum at least. Entrance to such work is discouraged without adequate entrance requirements slightly in advance of those for general university work. This advance characteristic usually means particular foundation in certain phases of mathematics.

Graduate Work

It seems likely that four years will always be the standard length of university work leading to a first degree in spite of a few exceptions. A fifth year as graduate work is readily available, normally bringing a Master's degree. Two years more or a total of seven years brings the student to the Doctorate (Ph.D.). The demand for this work is increasing and the route is well developed and standardized in this country. It is the opinion of the speaker that graduate work will be much improved in tone and value as chemical engineering graduates enter it in increasing numbers.

Without wishing to detract in the least from the merit of the students of other colleges, the speaker has for long emphasized to the dean of the graduate school of the Ohio State University that the graduates of chemical

engineering courses in this country constitute the finest graduate school timber available.

Growth of the Professional School

While this graduate route to five and more years of university training was slowly developing, other factors were at work in higher education influencing length of course. The outstanding case is that of medicine. Other professions such as law might also be mentioned. There has come about in higher education, therefore, a strong professional urge to lengthening the curricula. The movement has had various energizing factors. Undoubtedly the principal one was the need for a deeper and broader cultural and scientific foundation upon which to build professional or technical training, made necessary by the widening spread of education in general and the rapid march of scientific and industrial development. Those professions at least which come into daily man-to-man contact with increasing numbers of broadly educated clients found lengthened curricula the necessary means of promoting adequate professional status.

If not always in law at least in medicine the rapid expansion of scientific knowledge made deeper foundations in science the *sine qua non* of a real advance of the subject itself.

Other urges there were in plenty. Some lawyers appear to have felt that there were enough lawyers, and a little curtailment of supply would do no harm. The country does not appear to have objected. Perhaps because we do not appear to have had an engineer for president since George Washington, as is erroneously stated from time to time.

This general movement for curriculum extension, whatever its basis, gave us the professional school—work largely built upon two or more years in arts or cultural studies or even upon an arts degree.

Influence of Curtailment Factor

The curtailment of supply of young members of the profession partly due to enforced or required lengthening of curriculum will early become a matter of public concern, at least in the case of medicine. The value of the longer curriculum here is probably unquestioned but the growth of communities throughout the country, with increasing population, entirely destitute of medical service is arousing alarm and is a matter of discussion in our universities. The fact that medical service can come from the big cities in high-powered cars at infrequent intervals and leave high-powered bills for little or no examination, let alone service, does not promote very rapidly the common welfare. To the fact that the rural citizen has for some time been increasingly acquiring such benefits of civilization as the privilege of dying without benefit of clergy, is now being added the privilege of dying without benefit of science. He may be saved an incompatibility

over evolution but his survivors will be more interested in professional curricula.

This curtailment factor has also a bearing upon the length of chemical engineering curricula and the welfare of industry.

Extended Curricula in Chemical Engineering

While chemical engineers may not have worried so much about professional status as other groups, nevertheless chemical engineering is a profession. Chemical engineering education has, therefore, long raised the question of length of curricula from all angles which have affected other professional education.

Chemical engineering teachers are always interested, therefore, in discussion of the length of the curriculum. Even if other professional groups were not active this would be true, for probably no other branch of teaching is so profoundly interested in discussion and criticism of teaching methods and arrangements. As far as I know, no other branch of higher learning has had a society devoted for many years to the questions of education. The Society for the Promotion of Engineering Education has long been a vigorous organization, furnishing an outlet for much of the thought and study constantly being given to engineering teaching methods by those engaged therein. This gives these engineering teachers an advantage over most other teachers. The value of the Wickenden investigation is well-known.

Throughout the years, teachers of chemical engineering, in common with other educators, have asked themselves, (1st) whether too much is not being forced into the four-year curriculum, and (2nd) would the student not be better prepared to meet the demands of industry if his course in the university were lengthened?

Numerous educational experiments and developments have been conducted to answer these questions and with a substantial degree of success. It is probable that almost every institution represented in this conference is administering some form of lengthened curriculum. I need not mention to this body the conspicuously successful cases of extended curricula in chemical engineering. It is to be ardently hoped that such experiments and such developments will not be discouraged, but will continue. It seems natural as the average length of life is prolonged, that more time be given in the preparatory part of it. It would not seem unreasonable, therefore, if in due time a great group of chemical engineering students should subject themselves to the equivalent of six or seven years of university preparation.

The Four-Year Curriculum a Fixture

The general economic prosperity coupled with the continued demand from the industries, and the natural ambition of citizens in a democracy for

the future of their children, has brought, and will continue to bring, an ever-increasing number of students into higher institutions of learning. For this group four years will probably continue to be the limit of educational possibility for economic as well as traditional reasons.

Whether this prosperity expansion in student numbers had occurred or not, the arts and other colleges of the country are wedded to a traditional four years for a Bachelor's degree. They are proud of the fact that they are the largest in numbers in their student bodies. They resent movements which tend to curtail these numbers. Their objection, to be sure, is not frankly to loss of numbers, but rather to the diversion of interest away from the arts or cultural point of view. They feel they are preparing citizens for life and that this must necessarily prepare them for business also. If they are preparing for a profession they feel the arts foundation is also a good one upon which the profession should be built. The articulation in this regard with medicine is well-known. The articulation with engineering is not so successful, although it has met with results.

The arts college advises for the fifth year a Master's degree and for additional work a Doctorate, requiring seven years in all. This educational situation must be kept clearly in mind as it has a profound effect upon the interest of the student. It furnishes an alternative route to approximately the same industrial chemical responsibility and opportunity. Those of industrial and particularly of engineering experience realize the shortcomings of merely chemical training. It is another thing, however, to warn our students and still worse our otherwise very competent professors of chemistry. "Where there is no vision the people perish." The speaker has been told by more than one professor of chemistry in his own university that "anything you can do in a beaker you can do in a tank." "Anyone trained in chemical theory can solve any problem in industry." Our wishing this were true, is little contribution to one whose experience brings nothing to the question. Probably for this reason it was necessary to take the training of chemical engineers out of the hands of academic teachers of chemistry, though it must not be forgotten that to teachers of chemistry we owe the vision of a need for chemical engineering training and not to teachers of engineering.

The chemical engineering teacher experienced in the professional or technical branches, because he has usually been a man of actual industrial experience, has tended to emphasize the fact that the university or technical school gives the student the opportunity of laying a broad foundation in elementary fundamental subjects and that his real education is largely secured in the "University of Hard Knocks." We seem a little timid as teachers in emphasizing what we have discovered in our own experience: that 80 or 90 per cent of engineering experience is *common sense* coupled with *ac-*

curacy and *reliability*. It is the aim of chemical engineering education to lay a foundation which will make possible the full development of these powers by the individual. If there is a criticism which we have had everlastingly recurring, it is the failure of human beings in these three essentials. Engineers or technical graduates have not been free therefrom. This strikes at the very root of education, and is confined not at all to chemical engineering students.

Thus we see that whether from the point of view of the chemical engineer who, by a residuum of the old apprentice system of learning in contact with responsibility, believes the school should confine itself strictly to fundamentals and puts the man at the earliest date into industry, or from the point of view of the graduate school method of curriculum extension, there is a distinct stopping place at the end of the fourth year or at the normal place for the B.S. degree. At this point the student can smoothly proceed as a beginner into industry or proceed to some form of advanced or continuation training. Industry in some branches of engineering furnishes its own advanced or continuation training for the college graduate in its cadet systems well-known to you. Thus we see the four-year curriculum in some form is probably a fixture. There exists almost a necessity for a degree at the end of four years. This is obviously no reason for lack of interest in extension beyond the four-year period. It also should not interfere with any particular system of extension.

Curriculum Extension

The feeling among deans of technical institutions in the Mid-West seems to be along the line of the possible arrangement of a fifth year added to engineering curricula to be devoted rather exclusively to cultural and non-technical subjects. The difficulty lies in the decision as to the point of insertion, whether at the beginning or distributed throughout or at the end. The latter seems psychologically impractical, though the student could appreciate it at that point. In any event every one is awaiting the finding of Mr. Wickenden's investigation of the facts of engineering education.

The case of chemical engineering is more complicated than any of the other curricula in engineering. Its history is a factor which must be taken into account. Long before we had chemical engineering curricula, students were acquiring enough of chemistry in the universities and technical schools to meet to a certain extent many types of demand in the industries for chemical service.

The science of chemistry is so useful to mankind that we apply it in widely divergent fields. Chemical manufacturing and the application of chemistry to manufacture are but a portion of the usefulness of this science in its applications. One needs only mention agricultural chemistry,

physiological and medical chemistry, and pharmaceutical chemistry to realize that chemical engineering, important as it is, is but one of the demands for chemical intelligence in the world of affairs.

Chemical engineering, too, is important. Without doubt, it is increasingly destined to be the hand-maiden of all the other branches of engineering. Engineering will expand and develop as chemical engineering develops. Already the mechanical engineer realizes that his power design is a function of metals and refractories. Civil engineering is dependent upon concrete and water-proofing; electrical engineering upon special insulation materials, metals and glass; mining engineering is closer still to the chemical engineer, as are ceramic and metallurgical engineering. The architectural engineer is increasingly turning from natural materials and taking up with chemical products for the strength and effects which are demanded of him. This vision of chemical engineering is clear enough to us, and our job is to make it so clear to education in general that chemical engineering may receive an increasing support over that which is given to it now at any institution.

Since rapidly expanding industry is compelled, and is glad to welcome men trained in chemistry by whatever method, the chemical engineer has always a competitor for place. It will, therefore, be a serious question whether we can justify asking men to study chemical engineering through an extended number of years, as long as he can enter any arts college in the land, major in chemistry, taking a few fundamentals of engineering, such as mathematics, physics, mechanics, drawing, then pass on into a Master's degree or a Doctor's degree in any of the branches of chemistry and go out into the industries with the advanced prestige of a Doctor's degree. Industry is increasingly making place for such men with no introduction to application whatsoever. In industry they then must make their way and pick up the applications and many producers prefer to have their men do this. Most of us doubt whether this situation is ideal even if it seems useful.

It is more attractive if one is to spend six years in college to take a Master's degree in five years, and a Ph.D. in two years more, only adding one year to the other time.

Obviously the men with the chemical engineering training have more jumping-off points, to be generally useful, than any other type of individual. Industry, however, will do with what it can get.

Under the competition with the graduate school arrangement, a six-year curriculum in chemical engineering could only be feasible either under extraordinary inducement in the shape of unusual features and publicity or at institutions situated in congested manufacturing regions where serious curtailment of student numbers could be survived or where such curtailment was desirable. It could be expected to function like a limited

enrolment. In special cases, and in fact rather frequently, raising requirements increases enrolment.

It is doubtful whether chemical engineering education can ever go on a strictly professional basis. It lacks certain of the apparent essentials to such a method of organization. For instance, it can scarcely expect to get uniform laws and examinations for permission to practice which could be used to eliminate the product of the school not up to standard. In fact, there is violent opposition particularly among chemical men to *any* form of state licensing of engineers. The engineers in such a state as Ohio are so divided on the subject that no law has even been agreed upon. Even the American Engineering Council takes no stand in the matter and merely suggests a form of law for the guidance of those interested. Medicine has fought that battle through. Then, too, there is no united organization which dictates to school, press, and legislature as in medicine. We will always be divided between two organizations or societies, also; that devoted to chemistry primarily and that devoted to chemical engineering.

All of us recognize the fundamental nature of education and the importance of constantly discussing its ways and means. No teacher of experience is willing to arrogate to himself the decision that his method is the best one. An equally good tool in the hands of different artists gives different results, and some artists do astonishingly well with tools that seem impossible.

It is very important that we allot to everyone the right to reach their own conclusions and carry out their own program, though there is much difference of opinion along the line as individuals responsible for the program must eventually reach their own decisions. One should not hesitate to reach his own conclusions, even though all the others in the field disagreed with him. He must select his own means to the end. It is to be hoped, however, that in making our decisions, each of us will still keep his mind open to learn from the experience of others and not hesitate to change when experience indicates we should do so. It is particularly important that we should not assume that numbers constitute freedom from error or from bad judgment. It would be obviously wrong to assume that because four years are used by most institutions that four years is better practice. Such ideas would stop all progress. We must in our own minds keep these questions perpetually stirred up and allow nothing to be fixed. When we cease to make changes we are said to cease to grow.

The man who has made no errors is certainly to be congratulated, if he is not already dead.

It seems to me unnecessary for the teacher to be wedded to either the four-year idea, or the five-, or the six-. We in chemical engineering are in the position that whether our students are to be called chemical engi-

neers or whether they be graduate students, they will still keep coming. The need in industry is very great.

To sum it all up.

1. There is greater and greater need for highly trained men in the chemical engineering field.
2. These men should come from either or both, special extended curricula for chemical engineering at particular institutions or,
3. From graduate work in chemical engineering.
4. The industry needs beginners at chemical engineering, whose training will be completed in industry.
5. The four-year curricula will furnish the bulk of these men.

VITAMINS IN FOODS

"The Department of Industrial Law of Norway has just made public two patents for the addition of vitamins to food fats like butter, margarine, lard, olive oil, and other fats and oils, and to many other kinds of foods such as chocolate, milk products, meat extracts, cream, honey, etc.," says the Institute of Margarine Manufacturers.

"Vitamins are so widely distributed in our food supply," says the Institute, "that many industries do not feel that it is necessary to add vitamins to their products. The nutrition experts of the world have not yet recommended such a practice. The significance of the patents lies in the fact that the vitamin content of butter or of margarine, for example, can at a nominal cost be increased many times without changing the appearance, texture, or flavor of either product. No one knows to what extent this scientific discovery may affect the production of these two products."

Course of Uric Acid Traced. What becomes of uric acid? This is a question that Prof. Withrow Morse of Jefferson Medical College of Philadelphia has set himself to answer. In a paper before the recent meeting of the American Philosophical Society at Philadelphia he discussed some of the aspects of this vital physiological problem.

"The dietary factor," he said, "operates to increase uric acid troubles in Europe more than in this country. This is due somewhat to the fact that here we take less alcohol with our meals."

"Uric acid has," he continued, "an interest more than purely medical because it represents the end-product of chemical changes in the cells concerned with sex and heredity."

Recent work has shown that while a little uric acid is carried off by the organs of excretion much of it is destroyed in the blood. By means of a color test, Prof. Morse has demonstrated that one of the products into which it resolves itself can be found in the blood of some animals but not in others. For instance, the blood of herbivorous animals contains none of this substance, which is called allantoin, but that of humans has a very slight amount.

Prof. Morse is now working on a method by which he can determine just how much of the uric acid products can be found in body fluids.—*Science Service*

Correspondence

LABORATORY NOTE-BOOKS IN HIGH-SCHOOL CHEMISTRY

To the Editor:

The writer feels that some comment should be made with reference to W. G. Bower's article[1] concerning note-books in laboratory instruction. I am in perfect agreement with Mr. Bower's major contentions, namely that the pupil should have clearly in mind the purpose of an experiment, that the observations and results should be clearly formulated and the conclusions drawn on the basis of properly organized observations and results. However, the writer has proven, to his own satisfaction at least, that it is not necessary to write temporary notes in the laboratory and then rewrite detailed notes after the experiment has been performed in order to give the student the proper training in scientific thinking and expression. The writer agrees that merely filling in blank spaces with one-word answers will not give proper training in scientific expression, although this method was found to give satisfactory results so far as retaining the main facts of the experiment was concerned.

The tests which were given during the investigation previously reported[2] were framed so as to determine whether or not the student had reached correct conclusions on the basis of the observations made during the experiment. The results showed that those students who made temporary notes in the laboratory, had them criticized by the instructor and then wrote detailed complete notes, made only slightly better grades than those students who made briefer permanent notes at the time the experiment was performed.

The writer is convinced that questions can be given which will allow the student to make a satisfactory final record of the observations and results as the experiment proceeds and then reason to correct conclusions on the basis of the results obtained.

In this school an experiment is given as the result of a definite problem which has arisen and must be answered. The student goes into the laboratory with a very definite idea as to the object of the experiment he is to perform. The notes required consist of a brief statement of the object of the experiment and the answers to the questions given with the directions. These questions make sure that the student records the necessary observations, results, and conclusions. Equations must be

[1] This Journal, **3**, 419–25 (1926).

[2] *Ibid.*, **3**, 296–300 (1926).

written and problems solved as soon as the student is ready for this type of work. It is admitted that it will often be necessary for the instructor to add questions to those given in the ordinary manual or else use his own mimeographed copies of directions and questions. When the experiment is completed the notes are examined and if correct are accepted, otherwise the student is required to correct any mistakes which may have been made. The following day a brief test is given covering the experiment. This enables the instructor to give each student a grade for the experiment and also gives him an opportunity to discover whether or not the student has actually solved the problem involved. Each student is therefore careful to see that the experiment is done to the best of his ability.

The question naturally arises as to how the instructor can properly supervise the laboratory work and correct the note-books in one double period. Under the plan outlined it will not be possible for the instructor to assume the role of store-room keeper. All chemicals must be readily accessible to the students so that the instructor will be free to devote his entire time to questioning and giving suggestions, but never doing the actual work for the student. The teacher soon learns which students are capable and can give the larger share of his time to those who need help and guidance. If the notes are written according to the method given they can be corrected in a very short time. The best students will finish the average experiment in approximately sixty minutes and can be given optional work or allowed to return to the class-room for further reading. The writer has never found any difficulty in correcting all notes by the end of the period, providing too much work is not attempted. It is better to do less work and do it well than to attempt too much and do it poorly.

The statistical results which the writer obtained showed that the method outlined gave results which were on a par with the method of writing temporary and then complete final notes. In this day and age the chances are that Sally and John will have a date for the movies during the evening and the chemistry note-book will be forgotten, put aside to be done later or perhaps copied from some ambitious student who stayed home to do the work. We teachers of chemistry are often criticized because we take so much time for our subject and it is obviously unfair to the other teachers to ask a pupil to spend two periods in a laboratory and then another hour writing up the results obtained from the two work periods. If satisfactory results can be obtained by the shorter method why should the teacher ask the student to reorganize and rewrite his material and why should the already overburdened science teacher be asked to look over practically the same work again if it was carefully corrected the first time? The method given is complete enough to give proper training in scientific

thinking and expression but at the same time prevents the note-book from being a burden to pupil and teacher.

MORRIS F. STUBBS

TENNESSEE WESLEYAN COLLEGE,
ATHENS, TENNESSEE

TWO POINTS OF VIEW

TO THE EDITOR:

Instead of an exothermic expression of dissent from your comments in the May number, not agreeing with my point of view as to the legitimacy of the requirement of composition ability in examinations in chemistry, it will be of more value to all concerned if I may carry the analysis of the situation a bit farther.

"The ability to speak and write intelligibly of chemistry and things pertaining to it will play an appreciable part in the utility of chemical knowledge," say you in your editorial. This ability is a complex result of many factors, of which the result of instruction in chemistry is only one. Whatever portions of the resulting complex ability are due to chemical instruction are legitimate objects for consideration in evaluating results of this instruction. Thus far we are in entire agreement.

But if we analyze the remaining sections of this complex ability, we find that they are neither more nor less than the very matters that are taught as "composition and rhetoric" in the four years of high school. For example, College Board 1923 examination, question 14(*a*), is: "Describe briefly the production of pig iron in the blast furnace, giving the composition of the ore, the flux, the slag, and the fuel." In answering this question, in addition to the chemical information required, the pupil has to organize the material for logic and coherence. Taking as a sample of modern texts in rhetoric the Miller-Palmer "High School English," I find that the answering of this question involves the technics of Chapter 5, "Technique of the Paragraph;" those of Chapter 9, "Principles of Composition," in which unity, coherence, emphasis, etc., are taught; those of Chapter 10, "Description;" and at least a portion of those in Chapter 12, "Exposition."

My analysis leads me to believe, therefore, that a successful answer to this question involves nearly half a year's rhetoric instruction plus only a day or two's chemical study! Now I have purposely taken the most extreme case to illustrate the point involved; the degree to which abilities produced by instruction in English are required for answering successfully examination questions in chemistry, even if typically only a fourth or a tenth as great as in this case, is large enough to warrant our giving serious consideration to the matter.

The inarticulateness of the scientist, to which you refer editorially in the April number, is therefore not a matter of science training, but of

training in English. Pupils facing examinations in chemistry and chemists facing the difficulty of presenting their work forcibly to the public are alike the victims of insufficient (and possibly inefficient) instruction in language. They simply do not have the language training that is needed in order to secure language abilities which can be applied to chemical content. The "ability to organize one's ideas" and put them into language is not a specific chemical ability, but is a language ability which can be applied to chemical material as to any other. The chemical instructor is, as you say editorially, reasonably obligated "to acquaint the pupils with the terminology and the accepted usages of his science;" and to "frown on such illiterate crudities as are everywhere offensive." When he has done this, however, he has not come within reaching distance of teaching those abilities which examination questions require in many cases; and he would have to teach an entire course in rhetoric to accomplish any such result.

Interested though I primarily am in science instruction, I have gradually come to the conviction that instruction in English, specific and definite, is so important that it should be given both great time and great weight in counting academic units of credit. Because of its importance, English should be given definite and separate credit. As the examinations of today stand, English is given an unknown but large proportion of credit under the name of attainment in all the other subjects, from chemistry to ancient history, from commercial law to biology. I am appealing for a real quantitative analysis of the attainment of the pupil.

Finally, examinations and standardized tests alike have as yet not developed far beyond the stage of measuring or exhibiting chemical knowledge or information. Fully as important, even in the products of the beginning course, are the chemical points of view, the attitudes towards chemistry, and the specific ideals which chemical instruction may engender. Space does not permit of enlarging upon these here. I may, however, legitimately claim to have made, in my standardized tests in chemistry, the first attempt to take these aspects into consideration in a systematic way in measuring chemical achievement. It is my hope that the elimination of credit for English ability in measuring such attainment will, in tests made by future workers, go hand in hand with an attempt to include in the measured quantity these higher products of chemical instruction.

STEPHEN G. RICH

VERONA, N. J.

CORRECTIONS

TO THE EDITOR:

In an article on "Pandemic Chemistry" in the April issue of the JOURNAL OF CHEMICAL EDUCATION, Professor Bancroft says: "Yale University is

going to try a modified form of it (pandemic chemistry) this autumn, although there it is planned to be to some extent a substitute for the orthodox freshman chemistry." This statement is misleading and appears to be based on a misconception of the plans for the work here at Yale. A new course, designed for election by students in the three upper classes of Yale University, is to be given next year. This course is not, however, designed to be a substitute for the courses in freshman chemistry and is not open to freshmen. The impression gained from Professor Bancroft's article is that a modified "pandemic chemistry" is to be substituted for the existing courses in general chemistry, and this is not the case.

In our freshman courses we have cut, to what we believe to be the minimum, the amount of specific descriptive material. We attempt to develop the important theories and principles of the subject on the basis of descriptive facts; and we make the study of the economic aspects of the subject and the applications of the substances to industry and to everyday life an integral part of the course. Since the applications of chemistry and the importance of chemistry are based on the properties and reactions of substances, our courses are being shaped on the principle that an adequate idea of these can be gained only when the student sees the reason for the various applications of substances. To do this requires a study of the substances which are being applied.

STUART R. BRINKLEY

YALE UNIVERSITY,
NEW HAVEN, CONNECTICUT

TO THE EDITOR:

In connection with my article "Why Are Students Not More Interested in Chemistry?" in the last issue of the JOURNAL,[1] I wish to inform you that the example given showing the method of teaching division of decimal fractions is not printed in accordance with my correction of the proof. My reason for calling attention to this is that the whole thing is practically meaningless unless it is written correctly. The point which the students are taught is that the first figure in the quotient must be put directly over the last figure in the dividend used by the multiplication of the divisor by the first figure in the quotient. Thus the example given should be as follows:

$$\begin{array}{r} 100.7 \\ .076\wedge \overline{)\ 7.653\wedge 2} \end{array}$$

[1] THIS JOURNAL, 3, 556–9 (1926).

This allows the student to put the decimal point over the caret, and does away with the necessity of reasoning out where the decimal point belongs. He is thus able to do a problem of this type correctly without having used any reasoning process whatever.

DE WITT T. KEACH

YALE UNIVERSITY,
NEW HAVEN, CONNECTICUT

COÖPERATING WITH THE ENGLISH DEPARTMENT

April 23, 1926

Prof. Geo. W. St. Clair,
Department of English,
University of New Mexico,
Albuquerque, N. Mex.

DEAR DR. ST. CLAIR:

There are in the University Library copies of the following books:
"Creative Chemistry" by Slosson,
"Life of Pasteur" by Vallery-Radot,
"The Riddle of the Rhine" by Lefebure,
"Discovery, the Spirit and Service of Science" by Greggory,
"The Future Independence and Progress of American Medicine in the Age of Chemistry,"
"Chemistry in Industry," by Howe, together with a large number of other books treating chemistry in a popular manner.

Next year there will be offered through a committee of the American Chemical Society six prizes of $1000.00 each for the best six essays on certain broad topics of chemistry. This contest is open to any freshman in an American college.

I am wondering if it would be possible for you to permit, or even encourage, the writing of the regular themes in freshman English on the subjects of the titles which may be entered in this national contest.

I should like very much to have more of our freshmen competing in these national contests.

Very truly yours,

JOHN D. CLARK

PROFESSOR OF CHEMISTRY,
UNIVERSITY OF NEW MEXICO

April 26, 1926.

Prof. John D. Clark,
Department of Chemistry,
University of New Mexico,
Albuquerque, N. Mex.

DEAR DR. CLARK:

The suggestion, contained in your letter of April 23rd, that freshmen be allowed to take theme subjects from the field of chemistry, meets with my unqualified approval, since such a procedure might, while stimulating their interest in chemistry, prove to them at the same time that the writing of themes need not necessarily be the bore that most of them think it to be.

Very truly yours,

GEORGE W. ST. CLAIRE

ACTING HEAD,
DEPARTMENT OF ENGLISH,
UNIVERSITY OF NEW MEXICO

UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Surveillance Inspector.

The examination for junior surveillance inspector is to fill vacancies in the Ordnance Department at large, at salaries ranging from $1500 to $1800 a year. Applications must be on file at Washington, D. C., not later than July 6, 1926.

The duties of this position are, under immediate or general supervision, to perform simple technical laboratory and field work in connection with the testing, storage, and inspection of smokeless powder, high explosives, and loaded ammunition.

Applicants must have been graduated from a standard high-school course, such work to have included at least one year of elementary chemistry; and, in addition, they must have had at least two years of practical experience in the handling, inspection, or testing of smokeless powder or other explosives, either in bulk or in ammunition. Each successfully completed year of a course, majoring in chemistry or allied subjects, in a college of recognized standing, will be accepted as equivalent to one year of the required experience. Applicants who do not meet the requirement of high-school chemistry may substitute therefor six months of additional experience in chemical laboratory or closely allied work.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

CLASS-ROOM EMANATIONS

Allotropic forms are the forms of the elements that are found in all of the tropics.

A normal acid is one that may or may not exist.

Chemical energy is the ability to perform chemical experiments.

Transmutation means the carrying of a substance from one place to another.

An isobar is a bar with two thermometers on it connecting sea levels.

A physical change is one in which a substance changes into another, but still remains the same.

A water cycle is a rain spout and is used to carry water down from the roof of a house and many other things.

Name three physical properties of oxygen. Ans. Sulfur, mercury, and argon.

Give an illustration of physical change. Ans. Soup with beans in it.

Name the three scales used for marking thermometers. Ans. Fahrenheit, centigrade, and freezing. Fahrenheit is not very hot and it comes on thermometers in Spring. Centigrade comes about Fall and is good for the health.

An anemometer is an instrument for measuring wind Phylosophy.

The Atomic Theory was started by Mr. Atomic, an Englishman.

To tell which of two samples of ammonia water is the stronger, smell of them and the one which makes the most tears come in your eyes is the stronger.

Oxygen must have an atomic weight of 16, because if it didn't the atomic theory would all go to smash.

When a thing is nickel plated, iron is given an electric bath.

Oxidation is when something takes oxygen and they pass off together as a compound.

Pewter is an alloy of lead and alimony.

We breathe out carbon dioxide and beverages breathe it in. Beverages need carbon dioxide to grow.

Germanium Glass Described. Glass with higher refractive powers may be made by replacing the usual silicon dioxide with germanium dioxide. In a paper presented to the American Philosophical Society meeting at Philadelphia, Prof. Louis M. Dennis of Cornell University revealed a new method for extracting this comparatively rare chemical element from germanium bearing zinc ores.

Prof. Dennis has been conducting an extensive study of the preparation of metallic germanium and the various compounds of the metal in the chemistry department of Cornell for the last six years.—*Science Service*

Chemical Digest

RECONSTRUCTION

The amount of subject-matter available for study has been so much increased by the growth of modern science, and the rapid material expansion of our civilization has so changed the fortunes of the college, that there has arisen a need for "reconstruction" in college teaching. This need has been cited by Alexander Meiklejohn in a recent article.[1] He says:

> The growth of modern knowledge has made it necessary for the college to reshape the content and method of its instruction. But, on the other hand, that same modern knowledge has largely contributed to the building up of the material wealth and organization of our society. And this increasing wealth and organization of society has brought to the college enormous increase of its own wealth and organization. And this, in turn, has made practically impossible the reconsideration of college procedure which the growth of knowledge requires. At the time when necessity demands that the college study its own content and method it has been driven and forced by the pressure of external circumstances. It has been formed and shaped by the necessities of external growth in a period when all its powers were needed for the reconstitution of its own inner meaning and spirit. And so, by a curious turn in human affairs, the process of knowing has been thwarted by its own results. And the college has lost its sense of direction as a result of forces which make the finding and keeping of that sense imperative both for learning and for the life which learning serves.

Dr. Meiklejohn outlines a plan for a new college to meet the changing conditions and points out the main characteristics of such an institution. The college should be "small and free from growth."

> To make the attempt proposed we need a limited field of action and a relatively stable one. The first task is that of making the institution into a single thing, into a community dominated by a purpose which it is formulating. Out of what is now an aggregate, a collection of many things, we must make a coherent orderly place of learning. To accomplish this, it is essential that there be genuine intellectual acquaintanceship running throughout the community. The college body must be small enough and unified enough to know its own members. There is no doubt that at the present time our teaching units are absurdly large and unmanageable.

In regard to educational policy, he points out that

> There is at this point a current intellectual issue about which no institution of learning and no plan of an institution should dogmatize but which also no liberal institution can avoid. It is the question whether or not the separate parts of knowledge, the separate studies which men carry on can, in any important sense or degree, be unified, be made into a single study or inquiry. With this question the proposed college

[1] "A New College," *New Republic*, **46**, 215–8 (1926).

and every member of it must be concerned if it is to be in the proper sense liberal in attitude. This statement does not mean that twenty-five teachers are to be agreed as to some type of unity to which knowledge can be brought. It does not even presuppose that all are agreed that substantial unification of knowledge is possible. It does, however, recognize that to deal with problems concerning the interrelation of separate fields of knowledge is a primary task of those who seek to understand the world and our experience of it. It regards knowledge as an attempt to guide human living. It seeks for intelligence in living.

The first essential in the planning of such a college is the making of a faculty. The question involves estimates of the qualifications and attitudes of specific persons.

Young people must find themselves in the company of, in close and personal association with, scholars who are doing the thinking on which our life as a people depends. It is by contact with such thinkers in their work, that the art of right thinking is best acquired.

Of the method of instruction he says:

In teaching method the new college would attempt a radical departure from present procedures. It would largely eliminate the lecture as a form of instruction and would subordinate it to other methods. Our procedure has been too much that of attempting to give to students the results of work done by their teachers. As against this our teaching must be based upon work done by the student himself. We must attempt to develop in him intellectual independence and initiative. He must learn from his teachers how to study and judge for himself. He must form habits of study, must recognize problems when they appear, and find out how to deal with them by means of proper thinking. He must learn to think and to know what to think about.

The content of instruction, according to Dr. Meiklejohn, falls into two parts. On the one hand we have the relatively stable background of philosophy, history, and literature and, on the other, the rapidly developing and shifting methods and results of the social studies and of the natural and physical sciences. Both sets of studies must be adequately represented. He divides the curriculum, also, into two parts. First, the student must get acquaintance with the body of knowledge as a whole. Second, he must learn how the special students in some one field of knowledge do their work. The first two years should be given, therefore, largely to general inquiry. For the last two years courses of special study should be provided in order that the student can acquire the beginnings of scholarly technic. The new college should be sufficiently remote to have the quality of a separate self-sufficient community but should be near a large city or university through whose institutions the use of library and laboratory equipment could be secured. Of the administration the author writes:

In the last resort the greatest external defect of our present scheme of education is that our teachers do not feel a proper sense of responsibility for the work of the college as a whole. They are not, by corporate thinking, deciding what the college shall be and

do. In various ways they have drifted or have been driven into being men in charge of separate interests, men of departmental attitude. And in general, they expect that welfare of the institution will be guarded and controlled by other men who have authority for that purpose. From that attitude and its consequences we must find some way of escape. We shall not find it easily nor at once. If the difficulty came, as is often glibly asserted, from the enmity of some men to the cause of true learning, the remedy would be relatively clear and simple.

Dr. Meiklejohn concludes his article with this paragraph:

It is not the intention of this statement merely to criticize existing colleges and procedures. Nor is it suggested that a new college would master all the difficulties which now beset the theory and practice of college teaching. What the statement does intend, however, is to call attention to those difficulties under which college work is now being carried on. It suggests that a college freed by definite arrangements from such hindrances as can be removed might make a valuable contribution to the work which all alike are attempting. On every level of our educational work except that of the college such ventures have been tried with exceedingly valuable results. It is time that the attempt be made in the college where it is perhaps most needed and most important.

W. R. W.

Studies Unexplored Region of Spectrum. One of the least known sections of the spectrum has been investigated by Prof. K. T. Compton, well-known physicist, and C. H. Thomas of Princeton University.

In a talk before the American Philosophical Society at Philadelphia, Prof. Compton described the methods they have used to make more accurate measurements of the spectral region that lies between ordinary X-rays and the extreme ultra-violet than have hitherto been possible. Except for a small region between radio and heat waves this is the only part of the spectrum that has not been capable of receiving close and accurate study. Prof. Compton and Mr. Thomas have shown that in this region of very soft X-rays iron, cobalt, nickel, carbon, copper, and tungsten give out numerous characteristic radiations.

In the other regions of the spectrum, such as the ultra-violet section measured by Prof. R. A. Millikan, the radiations themselves can be more or less directly studied, but these very soft X-rays are so strongly absorbed and so little reflected that workers must resort to very indirect methods for their detection, such as the photo-electric methods described by Prof. Compton.—*Science Service*

Vitamin Value of Cod Liver Oil Varies. There is cod-liver oil and cod-liver oil, recent medical research seems to indicate. All the oleaginous liquid dosed out to the youth of the land does not necessarily contain the same amount of health-giving vitamins.

The beautiful pure white variety which is usually obtained from the cod when they are spawning is comparatively low in vitamins, according to investigations carried on by Prof. J. C. Drummond of the University College of London and Dr. S. S. Zilva of the Lister Institute. The oil with the most vitamins comes from the cod that are caught when they are actively feeding. The high vitamin content of the oil made from cod caught off the banks of Newfoundland is due to this fact, Prof. Drummond said in a recent report to the English medical journal, *Lancet*. Oil derived from shoals of the cod family actually feeding is from five to ten times as valuable as that prepared from fish taken during the spawning season, declared Prof. Drummond.—*Science Service*

ABSTRACTS

The Future of Chemistry in the Field of Medicine. H. A. SHONLE. *Accelerator*, **10,** 5–7 (1926).—Medicine should be preventive and not curative only. Life is the highest and most complex expression of the transformation of matter and energy. It is the most complex expression of chemistry and physics that is known. Health depends upon the exact and delicate adjustment of the speed of the various chemical reactions which take place in the body. Cell-secretion, cell-respiration, and cell-nutrition are but different aspects of the chemical reactions going on in the cells. Cell regeneration and cell death are controlled in some way which is chemical. The fertilization of the egg is a chemical phenomenon.

The complex problems of the body are too complicated to be solved by any one group of scientists; while they are chemical in their nature the chemist cannot carry them to a successful conclusion without the aid of the pharmacologist, the pathologist, the physician, the bacteriologist, and the experimental biologist. The isolation and determination of the structure of the biologically active principles of toxins and antitoxins and of the hormones of the glands is a problem fit for the ingenuity and ability of our best chemical minds. W. R. W.

Purpose in the American Colleges. A. FLEXNER. *Sch. and Soc.*, **22,** 729–36 (1925).—In continental Europe if one asks what is the end and aim of secondary education, the answer is definite and uniform: the responsibility of selecting, equipping, and training capable minds; utilizing accumulated intellectual and esthetic treasures of the race. American college administrators do not agree and are vague as to the objects of our own aims in education. In Europe, men who have passed through the gymnasium or university are as a rule educated. In America, it isn't necessary to presume that a man who has had a college education is educated at all. He may be, but relatively few are.

The peculiar thing that can be done practically nowhere else except at college is to select and train intelligence. Of course, this is not the only thing that ought to happen. When the incidentals of a college life become anything else than incidentals, when happiness, sport, and social relations are more highly esteemed than selection and training of intelligence, then somebody's time and money and talents are being wasted. American students have nibbled at a greater variety of things and at more periods than any other students on earth. Thoroughness is all but impossible because the intellectual atmosphere is not serious. Our present-day athletic frenzy is only another illustration that nature abhors a vacation—in this instance, an intellectual vacation. A nation's stock of achievements in art, science, philosophy, manners, and industry is its culture. We are cultured when we have mastered a field of human thought and endeavor, mastered it so thoroughly that we can see life broadly and as a whole. K. S. H.

"Points System" in Colleges and Universities. L. J. POLLARD. *Sch. and Soc.*, **22,** 727–8 (1925).—In order to study methods used by various colleges to control extra-curricular activities of students a questionnaire was sent to 505 institutions. 435 replies were received. There is great variation in the "points systems" used, but they may be divided into 4 classes. In general, the student is limited by a total number of points not to exceed 3 halves of a major activity and not less than the major activity itself. K. S. H.

Student Mortality. A. M. JORDAN. *Sch. and Soc.*, **22,** 821–4 (1925).—Students leave college because they fail to get the right start in their instruction. Other causes are—finances, health, and moral difficulties related to hazing or drinking. Students who leave have lower records in H. S., lower I. T., and lower college grades than those who stay. Sometimes students with high I. T. have left, the reasons not being known. The first term college record is the best simple prognostic measure of a freshman. K. S. H.

Industrial Measurement of Color. W. C. RAFFÉ. *Sci. Prog.*, **20,** 662–74 (1926).—A simple and convenient method for the estimation of color for industrial purposes is very necessary. The decorative and textile industries possess no accurate international standards. The lack of such standards hampers trade. "Owing to the singular poverty of language relating to color, we cannot yet correctly describe or even indicate accurately the simplest color in writing." Color, like music, cannot be described by any verbal language, yet the latter has a definite system of visible and easily written symbols. The tintometer is a very good means for measuring color and gives greater accuracy for organic substances than any other method. However, the tintometer can be used only for objective material and not for gaging the color of lights. The air and sunlight may affect standards.

Color is related to light energy produced by resistance of matter and is relative to human vision. It displays three variable qualities: brilliance, hue or chroma, and saturation. R. suggests the selection of the six principal colors of maximum saturation as standard. Slight alteration affects all three variables. T. G. T.

Do We Live in a Spiral Nebula? W. W. CAMPBELL. *Science*, **63**, 263–76 (1926).—A discussion of the probability of our stellar system being a spiral nebula in the light of recent determination of the motion of our solar system as well as other older data such as the general appearance of spiral nebulae and our milky way, the presence of dark absorbing material in spirals and in our own stellar system and the evidence of and speed of rotatory motion in both. The author concludes that our stellar system corresponds in most respects to a spiral nebula. G. H. W.

Scientists and the Income Tax. RODNEY H. TRUE. *Science*, **63**, 279–80 (1926).—A report by the Secretary of the Committee of One Hundred mainly concerned with exemptions. "Dues paid to charitable and professional organizations not run for profit are deductions permitted in computing the tax. All dues paid during the taxable year are included. This deduction should be made on the income tax blank entry under business expense." "While business men and engineers traveling solely for business purposes may deduct travel expenses, including cost of entertaining others, when it can be shown that the sums were spent on prospective clients, physicians attending medical conventions and scientists attending scientific meetings may not deduct traveling expenses." "When, however, members of a college or university faculty while on sabbatical leave travel, 'especially for the purpose of study, travel, and research work,' the information gathered being used to supplement courses of study on which they usually prepare reports to their superiors, traveling expenses incurred are allowable deductions from gross income." "Scientists, traveling as experts in connection with their profession, are allowed to deduct traveling expenses on the same basis as the faculty member traveling on sabbatical leave referred to above." "When college professors employ stenographers and clerks in connection with the activities from which they derive their income directly, the salaries paid by them are deductible, as also sums paid personally for stationery, office supplies, and equipment." "The cost of attendance at summer schools or post-graduate work is a personal expense and not deductible." "While the situation on depreciation of library apparatus and other professional equipment is not altogether clear, decisions in the main favor an allowance for depreciation, particularly where the taxpayer derives a material income from expert work." "From what has been said, it appears clear that in the administration of the income tax law, the scientist suffers in the matter of exemptions because of the absence of the idea of financial gain from his doings." G. H. W.

The Intellectual Worker. WILLIAM MACDONALD. *Science*, **63**, 317–21 (1926).—An attempt to determine the economic status of the intellectual worker. All grades of intellectual workers are considered. The lowest grade is the "white collar" man who does routine work. Concerning the status of the teacher: "It is unhappily possible, in most American colleges or universities, for a professor who has once taken the trouble to master the material of his courses, and who has learned by experience the routine which unfolds with the passing of the academic year, to continue indefinitely as a professor in good standing without adding materially to his knowledge or his intellectual power. What is true of the college or university professor is still more true of the teacher in the secondary school." If the conspicuous success of certain extraordinarily gifted intellectual workers is disregarded, the general economic level of this type of worker is low, perhaps lower than that of the skilled manual laborer and has not improved so much since the war as that of the manual laborer.

Three remedies are suggested: (1) Greater solidarity of intellectual workers, (2) insistence that the line be drawn more clearly in colleges and universities between teaching and research, and (3) more generous endowment of intellectual labor. G. H. W.

Problems of a Scientific Investigator. BYRON CUMMINGS. *Science*, **63**, 321–4 (1926).—A clearing house is suggested for the results obtained in the different branches of American Anthropology. G. H. W.

Coöperation in Research. FRANK E. E. GERMANN. *Science*, **63**, 324–7 (1926).—Coöperation among research men is divided into the following classes: I. Among men in the same science: (*a*) between men in the same department; (*b*) between men in different institutions; (*c*) between the universities and the industries. II. Among men in allied sciences: (*a*) between different departments of the same institution; (*b*) between university and industry. III. Coöperation in the form of loaning apparatus. Cooperation along these lines is expected to facilitate research work, and enhance mutual respect among scientific men. G. H. W.

Chemistry and Pure Science. B. B. BOLTWOOD. *Science*, **63**, 345–7 (1926).—A natural science may be descriptive or explanatory. Chemistry, like most sciences, covers both areas. It is difficult to distinguish between a pure science and an applied science. Although great respect is felt for applied chemistry, the contributions of eminent chemists have been to the advancement of science in its purest form.

G. H. W.

The Evolution of Man. *Science*, **63**, 350–1 (1926).—Minutes adopted by the Council of the American Anthropological Association: In view of the dogmatic objections raised against the theory of evolution the council of the American Anthropological Association have thought it advisable to formulate the present position of scientific inquiry.

The plants and animals belonging to early periods of the earth's history show that the forms have not remained the same for any length of time. The changes that have occurred are of such character that we are compelled to consider the later forms as descendants of older forms. No form of living being has remained the same through the ages. The evidence of past times is corroborated by the structural and developmental analogies observed in related forms, proofs of a gradual differentiation from common ancestral forms.

The minute structure of all living matter is alike and shows that all organisms, from the lowest to the highest, must be considered as a unit.

Man has succeeded in producing a variety of forms of domestic animals and cultivated plants which differ from their ancestors. Our success, accomplished in a very short period, indicates that in long periods nature will produce more fundamental changes.

Man is part of the animal world. In all respects his anatomical structure conforms to that of the rest of the animal world. His prenatal life closely parallels that of the higher mammals. The same influences that control their development after birth control him and he responds in a like manner to the environment in which he is placed. Prehistoric archaeology has shown that, in the course of the ages, man has undergone great changes in physical type and that ancient man differed from modern races, the more so the more ancient the remains.

Local types of man have developed on every continent and their existence proves that changes in the heritable characteristics of racial groups are effected in the course of time.

We must conclude that the bodily form of man as well as that of animals and plants has changed and is still changing, not in the course of centuries, but in long periods.

The exact cause of changes in the form of organisms and the conditions under which they occur, as well as the causes making for stability, are still imperfectly known. The principle of change has been so well established that it should become the common property of mankind.

G. H. W.

Is There a Difference between the Problems of Men and Women Teachers? HARLAN C. KOCH. *Educ. Res. Bull.* (Ohio State Univ.), **5**, 163–6 (1926).—The general feeling that more men should be at work in the school-rooms is made the subject of the article. The shortage in men teachers is not confined to America but the same difficulty is felt in England.

It is argued that boys need the influence of men in the school-room and, lacking it, drop out because the schools are becoming feminized. It is also claimed that men can accomplish more than women because they are stronger physically. The presence of men in the school-rooms implies the administrative situation. From the study undertaken by the author it was found that the sexes are not different in regard to the recognition of problems, their frequencies, their distribution, and the desire for knowledge of how to solve them.

In summarizing the results of the investigation the author found that

1. Men have problems in as great number and of as great variety as do women.
2. The character of the difficulties experienced by each sex is the same.
3. There is no particular advantage in having like sex deal with like.
4. The statement by Briggs, that it is probable that the qualities desired in a teacher are much more characteristic of an individual than of a sex, is supported by the data found.
5. Although a sociological justification for the attempt to interest more men in teaching may exist, there seems to be little justification in school administration, as such, for such effort. In fact, the sociological argument tends to lose its force, in so far as certain findings have sociological significance.

W. R. W.

A Study of Science Articles in Magazines. A. H. SEARLE AND G. M. RUCH. *Sch. Sci. Math.*, **26**, 389–96 (1926).—A study of the contents of eleven representative

magazines for the ten-year period, 1914–1923, to determine what scientific information was published and the relative amounts devoted to each science. Articles were classified into topical groups under each science and bar graphs constructed. It was found that the major topics in each science were represented but the quantity on the topics under each subject varied widely. B. H. B.

Culture *vs.* Education. EDITORIAL. *Chem. Bull.*, **13**, 113 (1926).—What is the purpose of a college education? "College chemistry should teach a student how to use chemistry as a tool—but the university should teach a man more than a mere trade. That function belongs to technical high schools. It is astonishing how few chemists are really men of culture and refinement." So much time is consumed by the required sciences that the prospective chemist has no time left for such interests as literature, philosophy, or languages. To meet this it is suggested that "an interest in cultural subjects should be given in high school. The man with a broad culture usually gets ahead faster, and in addition the language used in some of the scientific articles published might be greatly improved." B. C. H.

High-School Teacher's Answer to His Former College Professor's Letter. ANON. *Chem. Bull.*, **13**, 107 (1926).—The criticism of "educators" is met by the statement that "departments of education are about as likely to have men of first-rate mentality major with them as major in chemistry." Criticism of preparation of high-school chemistry students "sounds very much like the college professor's complaint, 'Our sophomores have been exposed to general college chemistry but precious few of them have taken it.' "

Note is made of the fact that most high-school students should be taught as prospective " 'consumers rather than producers' in the chemical world."

"Knowledge of the student" is placed upon a par with "knowledge of subject-matter and personality" as qualities desired in the teacher.

It is pointed out that theory of teaching is quite as important to a successful teacher as the theory of chemistry is to a successful chemist. "There *is* a great fund of helpful 'theory of teaching' even though some capable folks do not admit it."

B. C. H.

Peregrine Phillips, the Inventor of the Contact Process for Sulfuric Acid. E. COOK. *Nature*, **117**, 419–21 (1926).—A biographical sketch of the little known inventor of an important process. H. K. M.

Eka-caesium and a Suggestion about Radiation and the Elements. F. H. LORING. *Nature*, **117**, 448–9 (1926).—A discussion of the possibility of detecting possible traces of element 87 in potassium and rubidium and a statement that such investigation is under way. H. K. M.

Ozone and the Upper Atmosphere. H. E. ARMSTRONG. *Nature*, **117**, 452 (1926).—Let it be assumed that the conditions in the upper atmosphere be such that the change of oxygen into ozone is possible though not greatly encouraged, a large quantity being produced, during daylight only, because of the intensity of the solar effect. Then it follows, that the reverse action will take place only slowly and the accumulated energy be let down (electrically) only slowly, so covering the period of darkness, perhaps. H. K. M.

The Isometric Chromic Chloride Hexahydrates. J. R. PARTINGTON AND S. K. TWEEDY. *Nature* **117**, 415 (1926).—Viscosity determinations on aqueous solutions of the above salts by the comparative flow method gave consistent readings showing that for equivalent salt concentrations, the viscosities of the violet chloride solutions are much higher than those of the corresponding green solutions. This is in qualitative agreement with the formulas assigned by Warner. Presumably the coördinated nucleus affords the greater contribution to the viscosity of the solution, and one would expect solutions containing the larger nucleus to be more viscous. According to Britton's view the exact opposite should hold, since he considers the green solutions to be colloidal in nature. H. K. M.

Asymmetric Nitrogen Atoms in Natural Products. T. M. LOWRY. *Nature*, **117**, 417 (1926).—It has generally been admitted that, although optical activity can be developed in compounds containing asymmetric atoms of carbon, nitrogen, phosphorus, arsenic, sulfur, selenium, tin, etc., as well as in "centroasymmetric" compounds in which no asymmetric atom can be detected, all naturally occurring compounds owe their optical activity to the presence of one or more asymmetric carbon atoms. It is, therefore, somewhat of a surprise to discover that the salts of nicotine contain an asymmetric nitrogen atom in addition to the asymmetric carbon atom to which the free base owes its optical activity. H. K. M.

The Constancy of Atomic Weights. H. V. A. BRISCOE AND P. L. ROBINSON.

Nature, **117**, 377–8(1926).—The authors enter a plea for the retention of an open mind as to whether, in fact, elements as they naturally occur have always and everywhere the same atomic weight. They more easily ask for judgment to be reserved, as work done in their laboratories has provided the best evidence yet available for both constancy and variability in atomic weight. They discuss the cases of boron and silicon. H. K. M.

The Nature of Active Nitrogen. LORD RAYLEIGH. *Nature*, **117**, 381 (1926).—Attention is directed to his early work in which he showed that the luminosity of active nitrogen can, as it were, be squeezed out of it by compression. This is as telling evidence as any that the action is bi-molecular. H. K. M.

The Nature of Active Nitrogen. E. J. B. WILLEY. *Nature*, **117**, 381 (1926).—The heat of formation of active nitrogen is about 43,000 cal. per gram-molecule. The heat of dissociation of the nitrogen molecule is most probably of the order of 300,000 cal. per gram-molecule. The hypothesis that active nitrogen is atomic cannot well be substantiated and it appears that active nitrogen represents a metastable molecule at a not very high energy level. H. K. M.

Education as a National Asset. HERBERT HOOVER. *J. Natl. Educ. Assoc.*, **15**, 103–5 (1926).—An address. T. G. T.

Rural Life and Rural Education. FRANK O. LOWDEN. *J. Natl. Educ. Assoc.*, **15**, 107–9 (1926).—An address. T. G. T.

The Contribution of Slides and Films to Science Teaching. L. P. MILLER. *Educ. Screen*, **5**, 200–2 (April, 1926).—A concise and illuminating report of the results obtained from the liberal use of slides and films for science classes in Scranton High School. The various methods of using such material are first discussed, and a method which was found very successful in practice is outlined. Sources from which such material may be obtained are next given, and the author points out the great need of the completion and publication of a complete list of slides and films which are available. Suitable types of projectors are discussed. Pictures should be shown immediately following class assignments on the topic and should be preceded by suggestive questions on the most important points. The teacher should comment on the picture while it is being shown. The author concludes with a list of practical suggestions to teachers who may be interested in further pursuing the subject. A. P. B.

Education Pays Compound Interest Forever and a Day. T. R. L. EDITORIAL. *J. Fla. Educ. Assoc.*, **3**, 4 (March, 1926).—A very clever and highly pertinent comment on the present status of teachers' salaries. "The information that Socrates' annual income from tuition amounted to a present monetary value of $50,000," observes the author, "is confirmation to the culture of his Greece." Directing his remarks to the South, he continues: "Today we of the South are paying more to the engineer who moves the train than to the teacher who trains the man; more to the mason who sets up bricks than to the professor who sets up boys; more to the overseer of railroad laborers than to the overseer of academic laboratories; more to the high sheriff than to the principal of the high school; more to the county politician than to the college president." The argument is refreshingly different from that of significant but dull statistics and is pushed home with more than convincing logic. A. P. B.

Isotopic Composition and Atomic Weight of Chlorine from Meteorites and from Materials of Non-Marine Origin. W. D. HARKINS AND S. B. STONE. *J. Am. Chem. Soc.*, **48**, 938–49 (1926).—The uniformity of the value of the atomic weight of chlorine obtained from materials of marine origin has been explained as due to very thorough mixing. Assuming the whole number rule of Harkins and Wilson to be true, the present atomic weight value of 35.457 would indicate 77.15% of chlorine of isotopic number 1 and 22.85% of isotopic number 3. Material of meteoric origin has probably never been mixed with terrestrial material to any thorough degree, and it is therefore a matter of great interest to determine the atomic weight of chlorine of such origin and discover if the two chlorines are present in the above-mentioned ratio. Three other minerals of non-marine origin, apatite, wernerite, and sodalite, were also used as sources of chlorine for similar determinations. The authors give a rather full account of the procedures used, special technic, etc., and many tables of results which were obtained, all of which will prove highly interesting to those who are desirous of knowing something of the elaborate precautions which such work entails. The results which were obtained are highly interesting and important, in that the atomic weight of chlorine from all the non-marine sources is found to be identical with that of chlorine from marine sources. This would seem to be further evidence in favor of Harkins' theory that the relative abundance of isotopes is most largely conditioned by the relative stability of isotopes, that is, their stability with regard to the different types of both disintegration and

formation and also by the abundance of the atomic species from which they are formed. A. P. B.

A Simple Relation between Composition and Boiling Point. E. Q. ADAMS. *J. Am. Chem. Soc.*, **48**, 870–2 (1926).—It is oftentimes desirable to be able to calculate the boiling point of a normal organic liquid from other data. Perhaps the best known equation is that of Longuinesu

$$T/(D\sqrt{n}) = 100$$

where T is the absolute boiling point, D the density of the liquid, and n the number of atoms in the molecule. The author advances another expression, even simpler

$$T = \sqrt{20{,}000\ m}$$

where T is, as before, absolute boiling point, at 760 mm. pressure, and m is, in the case of hydrocarbons, the number of carbon atoms in the molecule. For other elements, the number of atoms is to be multiplied by one less than the row in the periodic table in which the element occurs. The formula may be very simply modified to give boiling point at any desired pressure, and such a modified formula is given as

$$T = T_p(1 - 0.2 \log_{10} p).$$

A table of calculated and observed boiling points is given, showing the accuracy which may be expected from the use of the formula. A. P. B.

Antiknock Materials. W. H. CHARCH, EDWARD MACK, JR., AND CECIL E. BOORD. *Ind. Eng. Chem.*, **18**, 334–40 (1926).—The authors present extensive data on the relative efficiency of various chemical compounds as suppressors of detonation in cylinders of internal combustion engines. The substances are compared to tetraethyl lead, the best-known antiknock material. A theory is developed to explain the action of a substance in preventing detonation, based on the decomposition temperatures of the antiknock bodies. The authors conclude that detonation tests conducted in an open tube do not furnish accurate indications of the behavior to be expected in an internal combustion engine; that some chemical phenomena other than simple oxidation probably accompany detonation; and that the problem of explaining the actual mechanics of detonation is much more complex than that of explaining its suppression or prevention. V. R. THAYER

Regulations Proposed Following the Tetraethyl Lead Investigation. SURGEON GENERAL'S COMMITTEE. *Ind. Eng. Chem.*, **18**, 432 (1926).—These regulations have been prepared for consideration at the meeting of state and territorial health officials with the Surgeon General in May, 1926. Provision is made for warning workmen and the public as to possible hazards involved in the handling of "tetraethyl lead," "ethyl fluid," and "ethyl gasoline;" for prevention of injury to workmen by dust or fumes containing lead, in manufacturing plants, garages, and filling stations; and for limiting the allowable amount of pure tetraethyl lead in salable gasoline to one part in 1300 by weight. V. R. THAYER

Vocational Course Recommended for Industrial Chemistry. ANON. *Ind. Eng. Chem.*, **18**, 380 (1926).—A summary is given of the recommendations made to the Federal Board for Vocational Education by A. B. Anderson, city director of industrial education at Wilmington, Delaware, for a course in industrial chemistry. The curriculum is designed for the training of laboratory assistants engaged in research and technical work in industrial plants. The announced aim is: "To train apprentices for laboratory assistants, technicians, or laboratorians for the industries of the Wilmington district. Advancement in this work usually leads to employment as helpers, foremen, or operators. Details of the various courses to be taught are given. V. R. THAYER

Is Commercial Synthetic Rubber Probable? L. E. WEBER. *Ind. Eng. Chem.*, **18**, 404 (1926).—Two separate steps are involved in the production of synthetic rubber: the manufacture of the parent hydrocarbon (usually isoprene) from some cheap and plentiful raw material, and the combining or polymerization of this hydrocarbon into raw rubber (caoutchouc). The most likely sources for the production of the first material are coal tar, petroleum oils, and starch. Methods of production from each of these raw materials are discussed. The author states that synthetic rubber so far produced has been inferior to plantation rubber in elasticity, abrasive resistance, and stability in aging; that production of a material equal to the natural caoutchouc appears difficult but will probably be accomplished in time; and that the plantation industry will be able to offer keen competition to any synthetic product through improvement of the yield of the rubber tree. V. R. THAYER

Chemical Engineering Permits Wider Use of Milk as a Food. ANON. *Chem. & Met. Eng.*, **33,** 157–9 (1926).—Although milk is recognized as an ideal human food, a considerable amount of its nutritive content is often fed to livestock, as is the case when the cream is used for butter production, while the skim milk is regarded as being of little value. Since an average analysis of fresh milk shows 87.5% water, 9% non-fat solids and 3.5% fat, the desirability of utilizing the skim milk as food is apparent. Development of suitable equipment for drying skim milk has made this feasible. The Gray system of instantaneous drying by atomizing under high pressure, employing special apparatus to secure the counter-current effect for milk and air, is described.
V. R. THAYER

Aiding the Progress of Glass Technology. A. R. PAYNE. *Glass Ind.*, **7,** 81–4 (1926).—The glass industry has been one of the last to abandon empirical or "rule-of-thumb" methods, in favor of scientific chemical and physical control. The author discusses the various sources from which research data of benefit to the glass industry may come, as follows: the Bureau of Standards, graduate schools of the universities, the trade association, the consulting chemist, the American Ceramic Society, and the trade paper. He notes that many problems on glass technology, of industrial and theoretical importance, are available for graduate theses, but that very few advanced university students are aware of this field.
V. R. THAYER

Research under Government Auspices. EDITORIAL. *Ind. Eng. Chem.*, **18,** 331–2 (1926).—The editor advocates four fields of research as being especially suitable for the scientific bureaus of the federal government. These are (1) problems bearing on national defense, (2) those involved with law enforcement, (3) investigations to assist the development of infant industries which are of vital economic importance and (4) pursuit of new truths of pure science. The stand is taken that the solving of industrial problems of immediate practical value may best be done by the research staffs of private organizations, thus leaving the government units free to develop the more fundamental theories of pure science upon which industrial progress eventually depends; and that legislators and their constituents should be informed of the ultimate soundness of such a policy.
V. R. THAYER

Roman Education. WENDELL S. BROOKS. *Educ.*, **46,** 476–85 (1926).—Roman education divided into three periods:

1. Earliest times to about 300 B. C. All teaching by parents. Much in the educational efforts of the earliest Romans that commends itself. Their method—the parents giving their personal attention to the education of their children in their own homes, and their insistence upon their children following an approved course of study which included much moral training and resulted in the inculcation of true reverence. The earliest curriculum, from the modern viewpoint, lacked literature, language study, and science.
2. 272 B. C.–150 B. C. Greek influence, establishment of schools, and teaching by slaves or persons other than parent.
3. 150 B. C.–100 A. D. Organized and systematized schools. During the third period an excellent organization was effected and was dominated by the best minds of the day. Its failure was due to the distracting spirit of later Imperial times.

T. G. T.

What Is the Matter with the Public Schools? SCHULTZ GERHARD. *Educ.*, **46,** 453–68 (1926).—Outlines the number of outside influences that affect the student's school work. The public school is unjustly blamed for much of the attitude of the modern youth toward his environment. It is rather the public, the home, and the family that is to blame. "Our whole educational system of today seems to be a monumental project of rapid transit through the kingdom of learning." Too much money goes into buildings and not enough into salaries. The public school does not get the desired results because of the large number of outside attractions.
T. G. T.

The Younger Generation. GUY VAUGHN PRICE. *Educ.*, **46,** 486–93 (1926).—"The ailments of youth are ailments of our present civilization. The salvation of youth is not to be found simply in the restoration of Puritanism in the home, not in religious education of the church, not in character building in the school, not in the censorship of the press, not in the elimination of the movie, but in a constructive transformation of these agencies."
T. G. T.

Forty Scientific Years. E. E. FREE. *Forum*, **75,** 41 (1926).—A review of the progress of science during the period 1886 to 1926.
J. W. HOWARD

The English Department. J. RALEIGH NELSON. *J. Eng. Educ.*, **16,** 453–7 (1926).—At the University of Michigan it is felt that better student English is being brought about in the engineering department through the efforts of Dean Cooley. This

is being accomplished by the engineering faculty instilling into their students a wholehearted respect for English. The English department is coöperating by aiding students in the writing of technical papers. It is thought that many students learn more about writing in this way than in formal courses in English. C. R. KINNEY

Supplementary Report of the Committee on Teaching Personnel. C. H. WARREN. *J. Eng. Educ.* **16,** 419–32 (1926).—This report supplements one published in December, 1925, and presents the distribution of the teaching loads of 2289 individual teachers in 76 engineering schools in the U. S. A. and Canada. The average teaching load for all ranks excluding deans is 18 hours per week. Departure from this average is very small, it being 17.2 for professors to 18.4 for instructors. It is estimated that the actual demand made upon a teacher's time would about double this. Data show that each rank carries a load exactly in proportion to the number of teachers in the rank. Engineering teachers spend very little time in research, the average being 1.3 hr. per week for all ranks. Outside professional work is also small showing that these teachers are mainly occupied by class-room duties. A few schools are doing excellent work in graduate courses—however, so many do little or none, that the average time for the individual teacher of all ranks is 0.5 hr. per week. These facts lead the committee to recommend 15 hr. per week as the proper time for a teacher to spend in the class-room. It also sees a need for improvement in the financial status of teachers to make any marked improvement in quality of teachers and teaching. C. R. KINNEY

Value of Engineering Practice to the Teacher of Engineering. W. O. ANDREWS. *J. Eng. Educ.*, **16,** 487–9 (1926).—Practical experience in the field of engineering is of even greater value to the teacher of engineering than research. Such a teacher "has learned the psychology and diplomacy" of dealing with his fellowmen. He has developed initiative and leadership and has a peculiar appeal to his students because he has "earned a living" at engineering. C. R. KINNEY

What Engineering Colleges Are Doing to Encourage Reading. HILDU J. ALSETH. *J. Eng. Educ.*, **16,** 503–9 (1926).—The College of Engineering at the University of Illinois has for a number of years been interested in encouraging general reading on the part of its students. This interest prompted the sending out of a questionnaire to the engineering schools of the country. Out of eighty-five usable replies it was found that only forty schools had separate reading rooms or libraries for engineering students. Only twenty-two schools maintain any general reading collection at all. Taken as a group, engineering schools are doing very little to encourage general reading, although most schools show an interest in the subject. C. R. KINNEY

Getting Acquainted with the Sales Department. WILBURN F. TURNBULL. *J. Eng. Educ.* **16,** 484–6 (1926).—W. F. Turnbull feels that engineering students should come in contact with the sales department of various business concerns as well as with the shops. The advantages so derived being: (1) students will realize that apparatus such as they learn to design really exists; (2) they will note the neatness, personal characteristics, and "ability to talk" of sales managers in contrast with shop foremen and workers; (3) they will make up to "selling talk," and will find they must judge for themselves; (4) they will find that the sales department always has a welcome for visitors, while in the shop or work room a student, although politely received, is a hindrance. C. R. KINNEY

Organic Glass. H. T. TENNEN. *Chemicals*, **35,** No. 11, 8–9 (1926).—A new synthetic resin called organic glass or pollopas resin is being manufactured in Austria. This substance is made by condensing urea instead of phenols, etc., with formaldehyde. It is reported to be fairly transparent and quite colorless. The manufacturers now claim that they can make it practically as transparent as glass. It has very similar optical properties to glass except that it is transparent to ultra-violet light. It does not splinter like glass, and although it breaks with a conchoidal fracture the edges are not sharp. It is about twice as strong as the best grades of phenol-formaldehyde resin. It can be worked nicely on a lathe. It is not attacked by the ordinary solvents, although a lacquer of the substance can be prepared. The unique properties of pollopas have suggested a great variety of uses, such as window panes in sanitoria and motor car windshields and windows. C. R. KINNEY

Colloid Chemistry in the School. R. WINDERLICH. *Naturw. Monatsh. biol., chem. geograph. geol. Unterricht*, **23,** 30–8 (1926).—The general idea is that colloid chemistry is too difficult and of too little use to be taught in the *Mittel* or even the *Hochschule*. W. shows nothing more concerns us in everyday life than colloid processes and suggests suitable material and experiments for an elementary course. R. E. P.

Local Activities and Opportunities

Columbia University. The Committee on the award of the Julius and Rosa Sachs prize of $1000.00, established at Teachers College, Columbia University, for the purpose of promoting the progress of secondary education in the United States has announced as the winner of the prize for 1926, Dr. Edward Augustus Fitzpatrick, Dean of the Graduate School, and Professor of Education, Marquette University, Milwaukee, Wisconsin. The subject of the essay is: "The Promotion of Scholarship in the Teachers of the Secondary Schools of the United States."

The prize is made from a fund known as the Julius and Rosa Sachs Endowment Fund. This fund of $20,000.00, was a gift made to Professor and Mrs. Sachs on the occasion of their golden anniversary and turned over by them to Teachers' College for the purpose of promoting by a series of prizes the progress of secondary education in the United States. Dr. Sachs' interest in this particular field comes from years of service as Professor of Education at Teachers' College. He now holds the rank of Emeritus Professor in that institution.

The award of the prize was made by the following committee: Dr. David Eugene Smith, Professor of Education, Teachers' College, and well-known as an authority on the history of mathematics and author of many text-books in that field. Dr. Edwin E. Slosson, Director of Science Service, Washington, D. C., and nationally known in the field of Science. Dr. William C. Bagley, Professor of Education in Teachers' College and a leader in the field of Normal School Education; Dr. Henry Osborn Taylor of New York City, eminent author; and Dr. Julius Sachs, Emeritus Professor, Teachers' College, and donor of the prize.

Dr. Fitzpatrick, the winner of the prize, graduated from the DeWitt Clinton High School, New York City, and received the degrees of Bachelor of Science, Master of Arts and Doctor of Philosophy from Teachers' College, Columbia University. He served for twelve years as teacher in the public school system of New York City; served for two years during the war with rank of Major; was secretary of the State Board of Education, Wisconsin, and at present is Dean of the Graduate School at Marquette University, Milwaukee, Wisconsin.

The second annual competition for the Sachs' prize of $1000.00 has already been announced. The topic of the essay or treatise for this second prize is: "The Aims and Methods of Science Teaching in the Successive Stages of the Secondary School and the Intellectual Equipment of the Teacher That Will Enable Him to Put These Aims into Practice." All manuscripts must be in the hands of the Dean of Teachers' College, on or before December 1, 1926. The rules governing the competition for the Sachs' prize may be secured from the Secretary of Teachers' College, 525 West 120th Street, New York City.

Carnegie Institute of Technology. Dr. V. N. Krivobok, Associate in the Bureau of Metallurgical Research of Carnegie Institute of Technology, has been awarded a grant of $500.00 by the Iron and Steel Institute of Great Britain to assist him in carrying out a photomicroscopic study of recrystallization of metals after cold-working, according to an announcement. Public announcement of the award, which comes from the Carnegie Research Fund of the Iron and Steel Institute, was made at the annual meeting of the Institute in London, on May 6 and 7, 1926.

Dr. Krivobok has been a member of the staff of the Bureau of Metallurgical Research of Carnegie Tech since its organiza-

tion by President Thomas S. Baker, two years ago.

An international conference on coal will be held at the Carnegie Institute of Technology in Pittsburgh the end of November, 1926, according to an announcement of plans now being devised by Dr. Thomas S. Baker, president of the Institution. The fundamental idea of the meeting is the discussion of new uses of bituminous coal.

Several prominent scientists of Germany, France, and England have been, or will be invited to participate in the discussions, according to President Baker's plans, and in addition, papers will be presented by a number of leading American engineers and scientists representing the latest discoveries in connection with the distillation of coal, its by-products, new methods of producing energy from coal, etc.

Some of the topics that are now receiving the consideration of President Baker and his associates for discussion during the conference are the low-temperature carbonization of coal, generation of power at the mines, domestic use of coke, and water power *vs.* coal energy.

An advisory board of leading American men of affairs is now being organized to assist in the conference plans.

N. E. A. C. T. The 101st meeting of the New England Association of Chemistry Teachers was held in conjunction with the 103rd meeting of the Eastern Association of Physics Teachers, May 15th, at Springfield, Mass. The program included the following: "Some Common Errors in College Entrance Examinations," Dr. Louisa S. Stevenson; "Some Contributions of the Chemist to the Rubber Industry," Dr. L. E. Weber; "On the Trail of the Molecule," Dr. Samuel R. Williams; and "The Dyeing of Silk and Rayon Both Alone and in Combination," Dr. Walter M. Scott.

Nebraska. Doctor C. S. Hamilton, University of Nebraska, department of chemistry, gave the public address for the open meeting of the Rho (Nebraska) Chapter of Phi Lambda Upsilon on April 22nd. His subject was "Chemistry in Medicine." The names of twelve men elected to membership were announced as a part of the program.

The Nebraska Academy of Science held its thirty-sixth annual meeting at Cotner College, Bethany, Nebraska, April 29th, 30th, and May 1st.

The principal address of the meeting was by Doctor B. S. Hopkins of the University of Illinois upon "The New Member of the Rare Earth Group."

The Chemistry section presented the following program:

FRIDAY, 2.00 P.M.

"Dissociation Apparatus," H. J. Wing, Doane College.

"A Possible Interpretation of the Crum-Brown Rule," R. H. Leroy.

"Activated Charcoal as an Absorbent," Dr. C. M. Knudson, University of Nebraska.

"Preliminary Report. Studies of Hydrolysis of Proteins," H. I. Stubblefield (Work under Dr. T. J. Thompson), University of Nebraska.

"Free Energy and Copper Halides," R. F. Nielson (Directed by Dr. D. J. Brown).

"Chemical Constitution and Physical Properties of Some Nebraska Clays," H. A. Rymes (Directed by C. J. Frankforter), University of Nebraska.

"Structure of Metallic Compounds of Benzyl Cyanide," Robert Maxwell (Directed by Dr. F. W. Upson), University of Nebraska.

"Organic Compounds of Arsenic," Carter C. Simpson (Directed by Dr. C. S. Hamilton), University of Nebraska.

SATURDAY, 9.00 A.M.

"Elementary Presentation of the Factors Involved in Oxidation and Reduction Reactions," Dr. D. J. Brown, University of Nebraska.

"Salvaging the Superior High-School Chemistry Student," Dr. B. Clifford Hendricks, University of Nebraska.

University of Florida. The class in chemical engineering has returned from its annual field trip, which includes visits

to several of the larger industrial plants of the state. Seven large plants were inspected, covering the manufacture, refining, or separation of a great variety of chemical products. The trip was under the supervision of Dr. W. H. Beisler, professor of chemical engineering.

A list of the prominent guests of the university during the past month includes the names of Hon. William M. Jardine, Secretary of Agriculture and Mr. Roger Babson of Boston.

The Florida Section, A. C. S., held its twelfth meeting on Saturday afternoon and evening, May 15th, in Science Hall. The program was as follows:

Afternoon

"High Points of the Tulsa Meeting," Dr. T. R. Leigh.

"Chemical Education in Florida," Prof. A. P. Black.

Evening

"Some Studies in Nutrition," Mr. J. H. Hansbrough.

"Chevreul as I Knew Him," Mr. Louis Parisot.

"The Missing Elements of the 7th Group," Dr. F. H. Heath.

A get-together dinner was held between the afternoon and evening meetings. Officers elected for 1926–27 are as follows:

Chairman—Dr. R. E. Ruprecht, Chief Chemist, U. S. Expt. Station, Gainesville, Fla.

First Vice Chairman—Dr. R. S. Bly, Prof. of Chemistry, Southern College, Lakeland, Fla.

Second Vice Chairman—Miss Nellie Morris, Chemist, State Road Dept.

Secretary-Treas.—Dr. W. H. Beisler, Dept. of Chemistry, U. of Fla.

Councillor—Dr. W. J. Husa, College of Pharmacy, U. of Fla.

Senate of Chemical Education—Dr. F. A. Gilfillan, College of Pharmacy, U. of Fla.; Mr. L. M. Drake, Drake Laboratories, Daytona, Fla.; Mr. Rollin Ebinger, Eustis High School, Eustis, Fla.

Dr. F. A. Gilfillan, professor of pharmacy, will spend the summer studying and travelling in Europe.

Three members of the chemistry staff were elected to membership in honorary fraternities during the year. They were Dr. F. H. Heath, Phi Kappa Phi; Dr. W. H. Beisler, Sigma Tau, and Prof. A. P. Black, Alpha Zeta.

Kentucky. The annual banquet of the Kentucky chapter of Sigma Xi was held May 21st at Lexington. The speaker of the evening was Dr. Edward Mack, Jr., of Ohio State University who spoke on the subject of "The Size and Shape of Molecules."

Kansas City Section, A. C. S. The 191st meeting of the Kansas City Section of the A. C. S. was held May 8th. Dr. John H. Calbeck spoke on the "New Developments in Pigment Manufacture." Carl F. Gustafson and Harry G. Clay opened a discussion on "Chemical Education." In the evening dinner was arranged for the members in the K. C. A. C.

University of Chicago. Marion G. Frank, Ph.D., 1923, has returned to Chicago after a sojourn of two years in China. During his stay in China he was professor of chemistry at Soochow University.

Professor J. W. McBain of the University of Bristol lectured on June 1st at 4.30 in Kent Theatre. Professor McBain's subject was, "The States of Matter as Exemplified by Soap Solutions."

Kent Chemical Society held its annual banquet in Hutchinson Cafe on May 25th at 6.30 P.M. The members of the Kent Staff were guests of the Society at the dinner.

Professor W. D. Harkins presented a paper on "Atomic Disintegration" at the April Meeting of the National Academy of Sciences.

Professor H. I. Schlesinger is convalescing after an operation for the removal of gall bladder. He is regaining health

satisfactorily and hopes to resume activities in Kent soon.

Professor Stieglitz is the editor of a new volume, "Chemistry in Medicine," to be published by the Chemical Foundation and is securing hearty coöperation from members of the medical profession.

P. T. Miller, head of the department of chemistry, University of Wyoming, is spending the year here in organic research. He is a candidate for the doctorate degree.

Professor W A. Noyes, Jr., addressed the Illinois-Iowa Section of the American Chemical Society at their Spring Meeting held in Galesburg, Ill., May 15th. His subject was "Light and Chemistry."

University of Maryland. Construction of the new chemistry building to be erected at the university will begin almost immediately. The entire sum appropriated by the state legislature ($210,000) will be employed in constructing the building itself. Sums necessary to equip the various laboratories have been donated by Dr. and Mrs. M. L. Turner of Berwyn, Maryland, Dr. H. A. B. Dunning of Hynson, Westcott, and Dunning, Baltimore, Dr. Samuel W. Wiley of Wiley and Co., Inc., Baltimore, and the Alumni Association of the university. The new building will be ready for occupancy February 1, 1927.

All true sciences begin with empirical knowledge—the record of facts obtained by observation and experiment.

It is work for the intellect to educe the elements of sameness amidst apparent diversity, and to see differences amidst apparent identity.—HUXLEY

New Structural Materials to Make Aircraft Safer. Structural material, and not engines or machine design, is the big problem today in aircraft development. Such is the experience of J. H. Kindelberger, engineer in charge of United States mail and military airplane construction in Santa Monica, Calif.

The imminent failure of the spruce lumber supply normally available from Oregon and Washington means that the all-metal plane is now the only real prospect of the future. Strangely, no material has yet been found, even in the domain of heat-treated steel and light alloys, which is equivalent, pound for pound, to straight-grained, clear spruce for the main skeletal support of an airplane. Millions of feet of spruce, in fact the major stocks of the northwest mills, have recently been rejected, however, by airplane lumber scouts. The few thousand feet of lumber deemed suitable for the work will be utterly inadequate in the face of the extensive development of the air service now in prospect. Thorough and most extensive research is now progressing with alloys of aluminum, copper, and manganese.

Sheet metal stampings and seamless tubes of aluminum alloys are proving successful for cross braces and minor support members, also for flooring and sheathing of various sorts. Castings, heretofore considered unsafe under the strain of air service, are being made of more ductile metal, and will be available.

In naval practice the aluminum alloys frequently come to grief, due to the great chemical activity of aluminum when exposed to sea water. Atmospheric oxygen, water, and salt transform an aluminum hydroplane skeleton into a mass of white powder. This oxidized powder may still retain its original form on account of the dried varnish shell about it, and accordingly be a source of deceptive danger. In as much as resistant metals are all relatively heavy, little hope is offered of an alloy that will stand actual contact with the sea. New varnishes are in prospect, however, to meet the situation with light-metal alloys.—*Science Service*

Recent Books

Popular Research Narratives, Volume II. Collected by the Engineering Foundation. Williams and Wilkins Co., Baltimore, 1926. 174 pp. 12 × 18.5 cm. $1.00.

This second collection of fifty popular accounts of scientific research contains considerable chemistry, but it is more interesting to the chemist for the insight it gives him into what the rest of the world is doing. The brief chapters contain readable explanations and discussions of such subjects as the sonic depth finder, the relationship of street lighting to traffic accidents and crime, sealing base metals to glass, the geophone, permalloy, the earth inductor compass, aerial mapping of New York, and the most modern conception of the electrical structure of matter. And for the most part each adventure in research is recounted by the "man who did it." Michael Pupin, President of the A. A. A. S., in his introduction compares science and engineering research to the bee gathering honey and urges that human society take care of the honey gatherers lest the stored-up honey be soon exhausted. The honey of science which has been collected in this little volume is a well-assorted sample which demonstrates the great contributions of science to the welfare of men.

The two volumes of Popular Research Narratives should be kept handy on the open shelves of the class-room library for they form a supplement to any encyclopedia or text-book, and a pupil who does not find something to interest him as he turns the leaves is so dull that he might well be dropped from the class at once.

E. E. Slosson

Laboratory Chemistry for Girls. Agnes F. Jaques. D. C. Heath and Co., New York, 1923. ix + 244 pp. 12.5 × 18.5 cm. $1.48.

This book is evidently intended for girls and women who are obliged to acquire in a short time some understanding of the relation of chemistry to everyday life. It was developed by the author at the Minneapolis Vocational High School in connection with courses given to nurses and home economics students.

The book is divided into four parts. Part I, consisting of three chapters, has to do with inorganic chemistry. The first chapter contains introductory material (on the types of chemical changes and on the properties of a few important elements and compounds) designed to familiarize the student with the language and methods of chemistry, by means of definitions, demonstrations, and experiments. The second and third chapters deal with air and water.

In Part II, which is entitled "Organic Chemistry," there are two chapters. The first chapter treats of carbon and of a number of carbon compounds, especially hydrocarbons, both aliphatic and aromatic. By means of graphic formulas, an idea is given of the constitution of various aromatic compounds of general interest, such as dyes, drugs, and perfumes. In the second chapter applications are made of the use of chemical reagents in the study of textiles, the cleaning of metals, and the removal of stains.

Part III, called "Food and Cleaning Chemistry," consists of an experimental study of sugars, starches, proteins, fats, and soaps. The experiments in each group are preceded by a brief discussion of the constitution of the substances concerned.

Part IV has to do with selected aspects of Physiological Chemistry, such as the action of the digestive juices and urine analysis.

Throughout the book the experimental work is supplemented by many reading references. Frequent questions not only serve as review, but also help to bring out applications of the experiments and to introduce additional material.

In her choice of subject-matter, illustrative experiments and applications the author seems to have adhered closely to her intention of emphasizing the practical value of chemistry in everyday life. The book should be considered by all teachers who wish to present in a limited time an idea of the nature of chemistry and certain of its applications.

Louise Kelley

Guide to Laboratory Chemistry for Girls. Agnes F. Jaques. D. C. Heath and Co., New York, 1923. vi + 195 pp. 12.5 × 18.5 cm. $1.48.

The purpose of this book is mainly to serve as a guide to those teachers using "Laboratory Chemistry for Girls," and to provide them with the background which the author has developed for her own use in connection with the laboratory manual.

The results of the experiments given in "Laboratory Chemistry for Girls" are recorded in detail and discussed fully. Information designed to aid the teacher in her discussion of the laboratory work is included. The book fulfils its purpose admirably and is therefore a useful supplement to "Laboratory Chemistry for Girls."

Louise Kelley

Chemistry in Agriculture. Edited by Joseph S. Chamberlain and C. A. Browne. xi + 384 pp. Illustrated. 13 × 20.5 cm. Pub-

lished by the Chemical Foundation, Inc., New York, 1926. Price $1.00.

This work continues the effort undertaken by the Chemical Foundation, in coöperation with the American Chemical Society, to popularize chemistry in its relation to our daily life, and splendidly supplements the first effort of the Foundation in publishing "Chemistry in Industry." The new volume "Chemistry in Agriculture," consisting of sixteen essays by prominent American agricultural chemists, brings together a wealth of information, presented for the most part in simple non-technical language, of great historical and educational value not only to the chemist but to the layman. It should serve a very useful purpose as collateral reading for high-school students, for students in courses in home economics, and for students in colleges offering special courses in the sciences pertaining to agriculture. The editors have correlated the writings of the sixteen essayists with consummate skill and with a minimum amount of repetition. Where repetition has occurred, for example, in the discussion of vitamins by three of the authors, it is neither tiresome nor uninteresting, as each author presents the matter from a slightly different viewpoint, which, for the young student and the casual reader without technical training, has distinct merit. Besides being a storehouse of condensed information, this book is calculated to arouse intense interest in the inquiring mind of the young student of science, intriguing the imagination to a marked degree. This is especially true of the chapters on "Crops and the Soil," by Dr. Thatcher, "The World's Food Factory, or the Plant in Air and Light," by Drs. Arthur and Popp, "Soil Life," by Dr. Lipman, and "Vitamins in Human and Animal Nutrition," by Prof. Dutcher. The relation and the importance of chemical technology to progressive and successful agriculture are forcefully set forth in several chapters, especially in those on "Where the Nitrogen Comes From," by Dr. Curtis, "Cereals," by Dr. Bailey, "Sugar and Sugar Crops," by Dr. Browne, and "Fermentation on the Farm," by Dr. Willaman and Dr. Gortner.

The statistical and historical data given are by authorities in their several lines of endeavor, they may be accepted without question, giving to the volume the character of a handy ready reference.

The book is well-printed in 11-point type with 48 excellent illustrations. The splendid halftones of such pioneers in the field of agricultural chemistry as Dr. Samuel W. Johnson, Sir John Lawes, Sir Henry Gilbert, Dr. W. O. Atwater, Dr. Henry P. Armsby, Dr. S. M. Babcock, Dr. H. W. Wiley, and Dr. Charles A. Goessmann add greatly to its charm.

The authors, the editors, and the Chemical Foundation are to be congratulated upon the production of "Chemistry in Agriculture."

W. W. SKINNER

TO BE REVIEWED LATER

Chemical Calculations—Jaffe.
Graded Exercises in Chemistry—Mendel.
Industrial Stoichiometry—Lewis & Radasch.
Potentiometric Titrations—Kolthoff & Furman.
Electrical Precipitation—Lodge.
Electricity and Structure of Matter—Southerns.
Chemistry to the Time of Dalton—Holmyard.

Whooping Cough Helped by Simple Remedy. That old reliable remedy, sodium bicarbonate, is now recommended in the treatment of whooping cough.

Recent work at the Kingston Avenue and the Kings County Hospital Laboratories, Brooklyn, N. Y., by Drs. J. C. Regan and Alexander Tolstouhov shows that this familiar bane of childhood is accompanied by a condition of severe acidosis which may be counteracted by small repeated dosages of simple alkaline salts, such as sodium bicarbonate, calcium carbonate, or magnesium oxide. In patients treated by this method early or late in the disease, a cure is induced.

Blood examination shows that the inorganic phosphorus content during whooping cough is lowered and the hydrogen-ion concentration is greatly increased. The alkaline doses bring about a rapid return of the phosphorus to its normal proportion in the content of the blood and counteract the acidity. These chemical changes in the blood are accompanied by pronounced improvement in the patients so that vomiting ceases, according to Dr. Regan, on an average within one week and whooping within two weeks, with occasional exceptions. The patients generally showed corresponding improvement and increase in weight. It has been suggested that the characteristic symptom of vomiting in whooping cough is a compensating mechanism of the body to eliminate the excess acid.—*Science Service*

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Coöperation from every hand has enabled us to bring the JOURNAL to the attention of hundreds who are now regular subscribers. They in turn have caught the spirit and are aiding in helping us to have the JOURNAL go forward by steady but sure growth. So during the summer months when we are sojourning if we will just casually mention to many of our friends something of the good things we have all enjoyed in the JOURNAL OF CHEMICAL EDUCATION, it will be a good piece of promotion work. The more readers we have the better it is for our authors. Eminent authorities like to write for large, intelligent audiences. Advertisers pay well to bring their wares to the attention of large groups. A better magazine will be the net result.

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